San Francisco Cable Railway
Washington and Mason Streets
San Francisco
San Francisco County
California

HAER No. CA-12

HAER
CAL,
38-SANFRA,
137-

Photographs
Reduced Copies of Measured Drawings
Written Historical and Descriptive Data

ADDENDUM
FOLLOWS...

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D.C. 20240

HAER
CAL,
38-SANFRA,
137-

HISTORIC AMERICAN ENGINEERING RECORD

San Francisco Cable Railway

Location:	Powerhouse and carbarn located at southwest corner of Washington and Mason Streets, San Francisco, California.Track located on Powell, Mason, Hyde, Washington, Jackson, and Taylor Streets, and Columbus Avenue.
Date of Construction:	Existing system originally built 1877-1892. Rehabilitated throughout its life.
Present Owner:	San Francisco Municipal Railway, City of San Francisco.
Present Use:	Cable railway.
Siginificance:	The last operating cable railroad in the world. Representative of an important type of urban transportation system intermediary between horse drawn vehicles and electric streetcars.
Historians:	Patrick W. O'Bannon, Marcia Osterhout, Steven Petrow, September 1981

INTRODUCTION

Cable railways thrived in American cities for the twenty years from 1873 to 1893, operating more than 300 miles of track by the early 1890's. San Francisco, site of the first cable railway, accounted for fully one-fourth of this mileage. Today only San Francisco's 4.7 miles of cable railway survive. This system is the last remnant of a transportation technology that played an important role in expanding urban mass transportation facilities and which served as an intermediate step between the horse-drawn streetcar and the electric trolley.

Two of the cable traction companies operating in San Francisco constructed the lines which comprise the existing system. In order to appreciate fully the place of these surviving lines in the history of cable traction technology it is necessary to examine all eight of the firms that built cable railways in San Francisco. Rather than describing at length the technology of installations which no longer exist, this report will confine itself to brief histories of each of the cable railroad companies in San Francisco, and will concentrate on their contributions to cable traction technology, the basic elements of the system having changed little over the years. A detailed technological description of the trackway elements, powerhouse installation, and rolling stock will be given only for those companies whose lines are represented in the surviving system. In addition to these sections on company history and the technology of cable traction, a separate section of the report will deal with the impact of the cable car upon the growth and development of San Francisco.

The technology of wire cable traction is both simple and derivative. Andrew S. Hallidie, often considered the inventor of the cable railroad, drew upon his experience with the ore haulage systems used in the mines of California and Nevada to develop the Clay Street Hill Railroad, San Francisco's first cable railway. Hallidie based his system upon an "endless" wire rope, running at a constant speed. Passenger cars are attached or released from the cable by means of a grip, controlled by the driver or gripman. It is this ability to grasp or release the cable at the gripman's discretion that distinguishes cable railroads from the mining systems. The essential elements of a cable railroad include the "endless" wire rope; a series of sheaves or pulleys that carry the rope through a slotted tube or conduit beneath the street; a stationary power source, originally steam and now electric motors, that drive the cable; and a gripping device to connect the cars to the cable and permit their smooth operation.[1]

Cable traction technology derived from the practice of using a wire cable driven by a stationary steam engine to draw loaded ore cars out of mines. Considering San Francisco's position as a provider of both capital and machinery to mining operations throughout the Far West it is hardly surprising that the first successful application of this mining technology to urban

[1]The Pacific Cable Railway Co., The System of Wire-Cable Railways for Cities and Towns as Operated in San Francisco, Los Angeles, Chicago, St. Louis, Kansas City, New York, Cincinnati, Hoboken, Etc. (San Francisco: 1887), p. 17.

transportation needs occurred in San Francisco. Andrew S. Hallidie, who constructed San Francisco's first cable railroad in 1873, relied heavily upon his experience with ore haulage systems when designing his street railway installation.

Hallidie was at least the third American to attempt to use wire rope traction for urban transportation. Charles T. Harvey patented a system in 1866 in which a gripping fork or claw on a car engaged ferrules on an open ended cable. Harvey actually built and operated a line in New York City using this system between 1868 and 1870. In New Orleans former Confederate general George F. Beauregard experimented with an overhead cable system in 1870.[2] At an even earlier date Philadelphian E.S. Gardiner patented the basic elements of the underground conduit used in by all later cable railways in 1858.[3] The degree to which Hallidie drew upon the work of these earlier inventors is unknown, but the essential elements necessary for a cable traction system clearly existed prior to his first interest in the subject.

The grip and cable represent an effort to forge a purely mechanical link between the period's horse-drawn streetcars and the stationary steam engine, the most common prime mover in post-Civil War America. Cable railroad engineers desired low speed engines of intermediate horsepower, usually of the Corliss type, easily adaptable to the variable loads experienced in daily operation of an urban transportation system. Large and heavy flywheels lessened the jarring and jerking resulting from cars gripping and releasing the cable.[4] Engines of this type made no special demands upon the talents of contemporary engine builders, frequently being ordered straight from the builders' catalogues.

Although simple, cable technology also proved both inflexible and expensive. Prior to 1880 all cable roads ran only in straight lines, curves being considered impossible. Construction costs for the conduit alone averaged $60,000 to $100,000 per mile, fully two-thirds of the full cost of the line.[5] In addition to the conduit, engines, and grip, a cable railway also required a variety of pulleys or sheaves to hold the cable down at the foot of steep grades and assist it over the summits of hills and around curves. The technology for negotiating curves, developed after 1880, required special construction work of a particularly heavy and expensive nature. Reversing the cars at the ends of the line necessitated either turntables or some type of switching arrangement.

THE CLAY STREET HILL RAILROAD

Andrew Smith Hallidie was born in London in 1836. His father, Andrew Smith,[6]

[2]George W. Hilton, The Cable Car in America (Berkeley: 1971), p. 17.
J. Bucknall Smith, A Treatise Upon Cable or Rope Traction as Applied to the Working of Street and Other Railways (London: 1887), pp. 9-15.
[3]Mining and Scientific Press, 43 (3 September 1881), pp. 145, 153.
[4]Street Railway Journal, 4 (October 1888), p. 263.
Hilton, p. 131.
[5]Hilton, p. 103.

held a number of patents for wire rope dating back as far as 1835. Young Hallidie's early training included work as both a mechanic and draftsman. In 1852, at the age of sixteen, Hallidie and his father came to California for the boy's health. Smith returned to England the following year, leaving his son behind.[7]

After a luckless stint gold mining, young Hallidie put his mechanical training to work, and in 1855, at the age of nineteen, designed and constructed a 200-foot long wire-suspension viaduct over the middle fork of the American River. In 1856 he began manufacturing wire rope, using one of his father's inventions, establishing a factory in San Francisco in 1857. Ten years later, in 1867, he took out patents for the "Hallidie Ropeway," a system for transporting ore out of mines by means of an overhead wire rope cable.[8]

Hallidie first turned his attention to the problems of urban transportation in 1869. He claimed, in a paper read in 1891, to have conceived the idea of adopting his ore haulage system to urban transportation needs after watching the agony of street car horses struggling to climb the steep grade of Jackson Street between Kearny and Stockton on a wet, slippery, evening.[9] It is a charming anecdote, and probably partially true, but it is doubtful that Hallidie invested thousands of dollars simply to relieve the sufferings of street car horses. His wire rope firm stood to increase its business and profits greatly should cable traction prove applicable to the urban setting.

Other evidence indicates that Hallidie did not originate the notion of using a stationary steam engine and an endless wire cable as the basis of a street railway system in San Francisco. A local attorney, Benjamin H. Brooks, acquired a franchise from the city in 1869 to construct a wire cable railway. Brooks and his engineer, W.H. Hepburn, a machinist at the Vulcan Foundry in San Francisco, laid their plans for the route, but failed to attract any investors. In 1872 they sold their franchise to Hallidie for a "nominal consideration."[10] It is unknown whether Hallidie borrowed Brooks'

[7] Hilton, p. 21.
Christopher Swan, Cable Car (Berkeley, California: 1978), p. 95.
[8] Hilton, p. 21.
Swan, p. 95.
Edgar M. Kahn, Cable Car Days in San Francisco, rev. ed. (Stanford, California: 1944), p. 28.
A.S. Hallidie, "A Brief History of the Cable Railway System Its Origin and Progress, and Papers in Connection Therewith," Report of the Mechanics' Institute Exposition, 1890 (San Francisco: 1891), p. 4.
A.S. Hallidie, The Mechanical Miners' Guide, 3rd ed. (San Francisco: 1879), p. 8.
[9] Hallidie (1891), p. 4.
Mining and Scientific Press, 43 (3 September 1881), p. 153.
[10] San Francisco Chronicle (22 April 1917).
Langley's San Francisco Directory: 1880 (San Francisco: 1880), p. 22.

and Hepburn's plans for his own project, but considering the controversy which later surrounded Hallidie and his draftsman, William Eppelsheimer, concerning the design of the Clay Street Hill Railroad it is not inconceivable.

Hallidie quietly began laying the plans for his own project in 1870, hiring an engineer named David R. Smith to survey a route along California Street between Kearny and Powell. The Sacramento Record published the news of Hallidie's intentions on 8 July 1870, and within a month a group of enterprising speculators had blocked Hallidie by securing a city franchise for a street railway which covered every street between Pine and Pacific.[11] This group apparently made no effort to develop their own traction system but merely secured the franchise in order to force Hallidie to buy them out. This tale may be a reference to Brooks' franchise, twisted over the years to make the attorney appear no more than a speculator intent on profiting from Hallidie's plans.

Between 1870 and 1872 Hallidie worked to perfect his plans. In 1870 he patented his first grip pulley, the device that drove the cable.[12] By 1872, Hallidie had eliminated most of the technical and legal obstacles, the acquisition of the franchise rights that year cleared the way for the construction of the road. The franchise granted by the city stipulated that the new line could not interfere with street traffic to any greater extent than existing horse car lines. Motors or engines which might frighten horses or people could not be used on the cars, which must be completely controllable at any point on the line. The franchise further stipulated that the line must be operable by 1 August 1873, and run daily between 5:00 am and 11:30 pm at a speed of between 3 and 8 mph, and that the fare be no higher than five cents.[13]

Hallidie was confident that the stipulations of the city franchise could be met easily, later stating that the "greatest difficulties were of a financial rather than of a mechanical character."[14] Efforts to induce the public to purchase stock in the venture failed miserably, only 120 shares being subscribed, and the entire project appeared in doubt due to "a lack of faith in the system."[15] Three associates of Hallidie's in the Mechanics' Institute of San Francisco, Joseph Britton, Henry L. Davis, and James Moffitt, all prominent businessmen in San Francisco, rescued the project in 1872, buying back the previously purchased shares of stock, and contributing $60,000 to the enterprise.[16]

[11] Mining and Scientific Press, 43 (3 September 1881), p. 153.
[12] Ibid.
[13] Smith, p. 21.
San Francisco. Board of Supervisors. Street Railroad Franchises Granted by the Board of Supervisors of the City and County of San Francisco and Statutes and Orders Relative to their Construction and Operation (San Francisco: 1884), pp. 1-6.
[14] Hallidie (1891), p. 5.
[15] Street Railway Journal, 1 (April 1885), p. 116.
[16] Hallidie (1891), p. 6.

During this time of financial uncertainty Hallidie abandoned his plans to construct the road on California Street, in part because his engineer, Smith, had taken a job in Central America. He determined instead to build two blocks north of California on Clay Street. Hallidie believed that because Clay reaches the summit of what is now Nob Hill it would provide a better demonstration of his systems' capabilities while also serving a more densely populated area.[17]

Hallidie and his three partners organized as the Clay Street Hill Railroad and took offices above the Clay Street Bank in June 1872. They sent out a prospectus to all property owners along the projected route that brought pledges of $40,000 contingent upon completion of the line, although the company ultimately received only $28,000 from the local property owners. Of the remaining funds needed to begin construction, $20,000 came from Hallidie, and $30,000 from the Clay Street Bank, which took a 10 year, 10% mortgage on the property.[18]

With financing secured, the mechanical questions resolved, and a city franchise in hand, the Clay Street Hill Railroad let the construction contract to W.H. Martin & Co., a bridge and wharf building firm. They broke ground on 2 June 1873.[19] Construction of the roadbed involved removing and replacing two sets of underground gas and water mains and filling in or building over the cisterns of the city's old fire system. Even so Martin & Co. virtually completed construction by the end of July 1873, after only about 60 days.[20]

The first trial of the Clay Street Hill Railroad took place at 4:00 am on 2 August 1873, four hours after the deadline set by the city franchise for the line's operation.[21] Hallidie presumably chose this early hour both to avoid calling attention to the fact that the line had not complied with its franchise, and to keep any possible failure of the system as inconspicuous as possible.

The trial run started a block east of the powerhouse at Jones, the conduit being complete only to that point. It was made by an incomplete dummy or grip car, whose brakes consisted only of four simple levers, each of which required a man to press it against the wheels. The brakes could not hold the car on the street's steepest grades, a deficency that proved "far from conducive to confidence, and the driver deputed to take the first car down succumbed to

[17] Mining and Scientific Press, 27 (27 September 1873), p. 200.
[18] Hallidie (1891), p. 6.
[19] Smith, p. 21.
Mining and Scientific Press, 27 (27 September 1873), p. 200.
[20] Hallidie (1891), p. 8.
[21] This first trial of Hallidie's line is traditionally dated as occurring on the morning of 1 August, however newspaper research indicates that it actually took place in the early hours of 2 August. The city franchise required the line to be operational by 1 August, but the trial took place so early the next day that apparently nobody noticed the failure to comply precisely with the stipulations of the franchise.

cogent scepticism regarding the relability of the scheme and his personal safety."[22] Hallidie took the place of the frightened gripman, and with a man stationed at each brake, and the entire car secured to telegraph poles by ropes in order to prevent a runaway, he began the descent of the hill. Despite the inadequate brakes the trip proved successful. The car was turned around at the lower terminus and made the return ascent without incident, demonstrating the practicality of the system. Hallidie described the moment as devoid of "frivolity," noting that "there was simply a mutual handshaking, and nothing but cold water.[23]

A public demonstration that afternoon with a dummy and its attached car, or "trailer," proved equally successful, attracting a large crowd. The press of people endeavoring to help turn the dummy at the lower terminus broke a bolt connecting the grip to the car, necessitating a twenty-minute delay. Nevertheless, some ninety people clambered aboard the train for the trip up the hill. The train stalled at Powell Street when the cable began to slip on the grip pulley in the powerhouse, but Hallidie remedied the situation by tossing some sawdust onto the overly tarred cable, increasing the friction and permitting the uphill trip to be concluded successfully.[24]

The Clay Street Hill Railroad opened for revenue service on 1 September 1873, following the completion of the conduit to the powerhouse at Leavenworth Street. For the first two days the firm offered free rides to the public in an effort attract riders and alleviate the public's fear of the new contraption.[25] Cars departed the termini at five minute intervals (three minutes during the evening rush hour) and took eleven minutes to run the length of the .6-mile long road.[26]

After an initial period of scepticism and distrust of the new system the Clay Street Hill Railroad became a great success. In February 1874 the line carried 76,500 passengers, and by 1876 monthly ridership averaged 150,000 as the area served by the line, what is now known as Nob Hill, developed.[27] Built at a cost of about $100,000, the line earned $220-230 per day in the years prior to 1877 with daily expenses of $120, resulting in a daily profit of $100, or $3000 per month. This amounted to a 5% return on the $60,000 invested by the firm's stockholders, despite the "poorly managed" state of the company.[28] A modern historian of cable traction, George Hilton, claims the road returned as much as 35% on the initial investment.[29]

The company extended its cable line west about .4 miles to Van Ness Avenue in 1877, replacing the horsecars the firm originally used to carry passengers

[22]Smith, p. 22.
[23]Hallidie (1891), p. 8.
[24]Hallidie (1891), p. 9.
[25]San Francisco Chronicle (3 April 1887).
[26]Smith, p. 34.
[27]Smith, p. 35.
[28]Real Estate Circular, v.13, n.1 (November 1877).
[29]Hilton, p. 23.

over this stretch of road. The earnings of Hallidie's company began to decline after the California Street Cable Railroad built a parallel line operating with a more modern physical plant.[30]

The Clay Street Hill Railroad remained independent until 1888, when the Ferries & Cliff House Railroad purchased it for $200,000, and incorporated it into its own Clay-Sacramento route. Service on the original installation ended on 9 September 1891, when the new owners decided to tear out the old double tracks and rebuild a single set of tracks along Clay. Following the final trip over the old road a bottle of champagne was broken over the dummy's grip as a tribute to this pioneer cable railroad.[31]

THE TECHNOLOGY OF THE CLAY STREET HILL RAILROAD

The Clay Street Hill Railroad, 2791 feet of narrow gauge (3-feet 6-inch) double track, ran on Clay Street from Kearny to Leavenworth, climbing 307 feet in seven blocks. The line's steepest grade, 16%, occurred in the block between Jones and Taylor. Hallidie made extensive use of redwood in constructing the line, because its experimental nature required that costs be kept to a minimum, precluding a more permanent type of construction.[32]

The cable conduit, which cost about $38,000 to construct, consisted of a series of cast iron frames, or "yokes," connected by wooden planking. The yokes were placed at 3-4 foot intervals in a 29-inch deep trench, to form the framework of the conduit. Two-inch thick redwood planking connected the yokes, forming the sidewalls of the 22"x16" tube in which the cable ran. Metal stays connected the tops of the yokes, stiffening the conduit and supporting wooden scantlings laid alongside the opening in the top of the yokes. These scantlings formed a 3/4-inch wide slot, set two inches off the centerline between the tracks. The gripping device entered the tube through this slot. Iron straps screwed to the tops of the scantlings protected them from excessive wear. Wooden ties extended laterally from each yoke, supporting stringers which carried the line's 30-pound Tee rails. Packed earth surrounded the entire conduit, holding it in position and supporting the wooden planking that formed the surface of the roadway between the slot and the rails.[33]

The cable ran inside the wooden-walled tube, supported about every 40 feet by iron carrier pulleys, 11 inches in diameter. At the summits of grades 4-foot diameter crown pulleys supported the cable. Hallidie installed fixed depression pulleys where the grade of the road changed at the base of hills.

[30] Hilton, p. 186.
[31] Scientific American, 65 (31 October 1891), p. 276.
[32] Hallidie (1879), p. 64.
Smith, pp. 26, 34.
Henry Root, Personal History and Reminisence with Personal Opinion on Contemporary Events 1845-1921 (San Francisco: 1921), p. 41.
[33] Hallidie (1891), p. 7.
Mining and Scientific Press, 51 (18 July 1885), p. 34.
Scientific American, 32 (17 April 1875), p. 239.

These 7-inch diameter pulleys prevented the cable from rising to the top of the tube and damaging itself against the underside of the slot. The off-center design of the slot, combined with the "L" shaped foot of the grip, allowed the grip to pass these depression pulleys without striking them. The offset slot also afforded the cable some degree of protection from the water and debris that fell through the slot into the tube.[34]

At each end of the line, in an underground vault set just beyond the tracks, sat an 8-foot diameter horizontal sheave that reversed the direction of the cable and sent it back through the conduit on the opposite side of the street. Each reversing sheave was mounted on a wheeled carriage riding on 10 feet of track. A chain connected the carriage to a 3300-pound counterweight suspended above a pit at the end of these tracks. The counterweight kept a constant tension upon the cable, compensating for the daily changes in its length resulting from variable loads on the line, changes in the weather, and other factors.[35]

The line also provided facilities for reversing the direction of the dummies and trailers at each end of the line so that they could be dispatched along the opposite set of tracks. At the lower terminus on Kearny Street, two turntables, sitting side-by-side, reversed the cars. As a train approached the end of the line the crew uncoupled the cars, ran the dummy onto the first turntable, turned it 90 degrees by hand and rolled the car onto the second turntable. The crew then turned this second turntable another 90 degrees until the dummy faced back up the tracks. After pushing the car forward to a point where it could retake the cable, the crew repeated the operation with the trailer, recoupled the cars, and started them on the trip up the hill. At the upper, Leavenworth Street, terminus the cars passed over a turnout and were reversed using a single turntable.[36]

The firm's powerhouse, a single-story wooden building measuring 68'x68', stood at the southwest corner of Clay and Leavenworth. The boilers, and steam engines for the line occupied the basement of the building, the winding machinery occupying a vault set 15 feet below the sidewalk. Horizontal deflecting sheaves, eight feet in diameter, diverted the cable from the conduit into the powerhouse, where it passed around an 8-foot diameter grip pulley designed and patented by Hallidie. Jaws set along the outer rim of the pulley alternately grasped and released the cable as the pulley revolved, supplying the adhesion necessary to drive the cable without letting it slip. From the grip pulley the cable passed around an 8-foot diameter tension sheave, back around the grip pulley, and then exited the powerhouse. It was diverted back into the conduit by another 8-foot diameter deflecting sheave. The tension sheave, which could be moved away from the grip pulley along a 60-foot bedplate, took up the long-term stretching that occurred in the cable.

[34] Mining and Scientific Press, 51 (18 July 1885), p. 34.
[35] Ibid.
Smith, p. 39.
[36] Mining and Scientific Press, 51 (18 July 1885), p. 34.
Scientific American, 32 (17 April 1875), p. 239.

Since the cable passed over the bedplate twice, coming and going from the tension sheave, 120 feet of cable could be taken up.[37]

Two 14"x28", 30hp horizontal steam engines, built by the Delameter Iron Works of New York, drove the winding machinery, supplied with steam by two 54"x16' boilers. Only one boiler and one engine operated at a time; the other set constituting a reserve. Pinion and spur gearing connected the engines to the winding machinery, which initially drove the cable at 4 mph, increased to 6 mph about 1877.[38]

Hallidie determined to use a separate dummy and trailer for the Clay Street Hill Railroad in order to avoid wasting passenger space by placing the grip in the middle of the passenger car, and to afford the gripman a better view of the street. The Kimball Manufacturing Co., a car and carriage manufacturing firm based in San Francisco, built the 2200-pound dummies. In addition to standard shoe-type wheel brakes, each dummy also carried two other braking systems: a pedal-actuated brake that pressed a shoe against the rails, and an iron drag pole to prevent the car from slipping down a grade. As a last resort the grip could be raised against the top of the conduit as a crude emergency brake.[39]

Although Hallidie is generally credited with designing the gripping mechanism used by the Clay Street Hill Railroad, and although the patents for the device are in his name, it appears that his draftsman, a German immigrant named William Eppelsheimer, actually worked out most of the mechanical problems involved in developing an operable gripping mechanism. In the articles he wrote for the British magazine Engineering, J. Bucknall Smith baldly stated that "this gripping apparatus was designed by Mr. Eppelsheimer."[40] It is interesting to note that the "Hallidie grip" saw service on only one other cable railroad. Meanwhile Eppelsheimer, having parted from Hallidie's employ, went on to become one of the most important engineers working in the field of cable traction.[41]

Hallidie and Eppelsheimer's grip consisted of a large hollow screw fastened to the floor of the dummy. This screw raised and lowered the grip mechanism within the tube by means of a hand wheel. An upper hand wheel worked a

[37] Mining and Scientific Press, 51 (18 July 1885), p. 34.
Smith, pp. 37-39.
Mining and Scientific Press, 43 (3 September 1881), p. 156.
[38] Mining and Scientific Press, 43 (3 September 1881), p. 156.
Hilton, p. 186.
Smith, pp. 36-37.
[39] Mining and Scientific Press, 27 (27 September 1873), p. 200.
Mining and Scientific Press, 43 (3 September 1881), pp. 154, 156.
Hallidie (1891), p. 6.
[40] Quoted in J. Bucknall Smith, A Treatise Upon Cable or Rope Traction as Applied to the Working of Street and Other Railways, 2nd ed., George W. Hilton ed. (Philadelphia: 1977), p. 197.
[41] Street Railway Journal, 11 (May 1895), p. 312.

threaded rod which ran through the hollow screw and operated the grip's jaws. These jaws, made of replaceable, soft cast iron, were supported by an "L" shaped foot carrying two sliding frames. By turning the upper hand wheel the gripman moved the frames, bringing the jaws into contact with the cable. A pair of grooved pulleys guided the cable between the jaws. H.J. Booth & Co.'s Union Iron Works built the first of these grips.

When a gripman desired to take the cable, which could be done at any point on the line, he opened the jaws with the upper hand wheel and lowered the grip over the cable using the lower hand wheel. Turning the upper wheel, he then closed the jaws until the guide pulleys contacted the cable, which could run freely over the pulleys without contacting the jaws. Tightening the upper wheel further brought the jaws gradually into contact with the cable, imparting motion to the dummy and its attached trailer.[42]

During its first months of operation the line experienced a great deal of trouble with its dummies. The first cars behaved like "untamed steeds," kicking "up into the air, much to the alarm of the passengers." Repairing the damage these dummies daily inflicted upon the cable and the conduit often required all night during the first months of the line's operation.[43]

When the firm initiated revenue service in September 1873 it employed two new dummies with large diameter wheels in the front and smaller ones in the rear. This design also proved unsatisfactory, exhibiting a disturbing tendency to rear up and jump the track, snapping the grip shank off in the conduit. The design of the dummy remained imperfect until early in 1875, almost a year and a half after the line's first trial.[44]

Between August and October 1877 the firm extended its cable line .4 miles west on Clay to Van Ness Avenue. This construction utilized a modified yoke, weighing 380 pounds, which extended under the rails giving them added support. The conduit walls of the extension consisted of a light iron casing instead of the redwood planks used in the initial construction.[45]

THE SUTTER STREET RAILROAD

Henry Casebolt's Sutter Street Railroad, incorporated out of the old City Front, Mission & Ocean Railroad in 1863, converted one of its unprofitable horsecar lines into San Francisco's second cable railway. Unlike the Clay Street Hill Railroad, the Sutter Street line ran over fairly level ground, its highest point being only 170 feet above the elevation of the lower terminus, and its steepest grade only 4%.[46]

[42] Mining and Scientific Press, 43 (3 September 1881), p. 155.
Smith, pp. 32-33.
Hallidie (1891), p. 6.

[43] San Francisco Chronicle (3 April 1887).

[44] Ibid.

[45] Mining and Scientific Press, 51 (18 July 1885), p. 35.
Smith, p. 35.
San Francisco Chronicle (3 April 1887).

When Casebolt first expressed interest in converting one of his horsecar lines to cable in 1876, the Clay Street Hill Railroad's owners demanded a $50,000 license fee for the use of their patents and a royalty on every grip used by the new line.[47] Outraged, Casebolt determined to design his own system, circumventing Hallidie's patents. Along with Asa Hovey, an employee of his car building firm, Casebolt designed the new cable line's physical plant.[48]

The Traction Railroad Co., a holding company formed in 1875 for Hallidie's cable railway patents, instituted a suit against the Sutter Street Railroad. It claimed Casebolt had infringed upon Hallidie's patent for a dummy equipped with a grip working in an underground conduit. In 1880 the United States Circuit Court decided the case, ruling that Hallidie's prior use of this invention constituted only experimental use, and that a patent for a device not yet perfected could not be infringed. The Court ordered that the Sutter Street Railroad pay $1 in damages to Hallidie.[49] This case was the first in a series of patent suits which characterized the cable traction industry throughout its history.

Conversion of the property from horsecar to cable operations took place in 1876, and on 27 January 1877 the line initiated revenue service, running from the intersection of Market and Sutter Streets west on Sutter to Larkin.[50] The change from horse to cable proved immediately successful. Ridership increased by 962,000 during the first year of operation.[51]

The success of this first line soon led the company to extend its cable operations. In late 1878 the firm opened the first crosstown line in the city, running from the powerhouse at Larkin and Bush south on Larkin to Hayes, in late 1878. Upon completion of this line the firm extended the main line west on Sutter to Central (now Presidio) Avenue. Opened in October 1879, this extension constituted the first movement of the cable lines into the sparsely developed section of the city known as the Western Addition, and brought the total amount of track operated by the firm to 2.5 miles on Sutter and .7 miles on Larkin.[52]

Robert F. Morrow, a local real estate broker, bought out Casebolt in 1883, and began another expansion of the firm's cable lines. Morrow abandoned the powerhouse built at Sutter and Presidio in 1879 to drive the western end of the Sutter Street cable in favor of consolidating the firm's operations into a single powerhouse located at Sutter and Polk. He further extended the Larkin

[47] San Francisco Chronicle (22 April 1917).
[48] Street Railway Journal, 11 (May 1895), pp. 312, 315.
Langley's San Francisco Directory: 1875 (San Francisco: 1875).
[49] Mining and Scientific Press, 40 (15 May 1880), p. 305.
[50] Hilton, p. 187.
[51] Smith, p. 42.
[52] Mining and Scientific Press, 43 (3 September 1881), p. 158.

line south, across Market and down 9th Street, to Mission. Work crews pressed this extension forward rapidly, hoping to cross Market in front of the tracks being laid by the Market Street Cable Railway, and thereby earn the advantage of seniority at the cable crossing. At any intersection where two cable roads crossed it became necessary to pass one cable over the other. In San Francisco the senior line, that firm which ran its tracks across the intersection first, invariably received the right to the more desirable upper position. To avoid striking the senior firm's cable the cars of the junior company had to drop the cable and retake it on the other side of the intersection. A legal action won the superior position at the crossing for the Market Street line, which possessed an earlier franchise, despite the efforts of Morrow's work crews, but the Larkin line held the superior position at all of its six other cable crossings.

The Sutter Street Railroad was renamed the Sutter Street Railway in 1887. That same year the firm extended its Larkin Street line farther south on 9th Street to Brannan. The following year construction crews pushed the cross-town line north on Polk from the powerhouse to Pacific Avenue, and then west out Pacific to Fillmore. The firm's financial success during is indicated by newpaper reports of earnings of between $1500 and $1700 per day in 1888.[53]

The company rebuilt its entire system in 1890-91, continuing daily operation of the lines throughout the work. During this reconstruction the firm also extended the Pacific Avenue branch west from Fillmore to Divisadero. This addition gave the company a total of approximately six miles of cable track, as well as a mile of horsecar track that connected the Sutter and Market terminus with the Ferry Building.

The Sutter Street Railway became part of the United Railroads of San Francisco in 1902, in conjunction with two electric streetcar companies and the Market Street Railway. The new firm, controlled by eastern capitalists, operated the Sutter Street lines until 18 April 1906, when the earthquake and fire destroyed the powerhouse, most of the rolling stock, and portions of the conduit. United Railroads, intent upon cutting operating expenses to the bone in order to pay dividends on the firm's watered stock, converted all of the old Sutter Street Railway lines, with the exception of the Pacific Avenue route, to the more cost effective electric streetcars following the earthquake and fire. The Pacific Avenue line, operating out of a small powerhouse at the corner of Polk and Pacific, ran over grades beyond the capabilities of the period's electric streetcars. The survival of this last vestige of the Sutter Street Railroad, which went out of service on 29 November 1929, depended as much upon the objections of the wealthy residents along its route to "unsightly" overhead trolley lines as it did to the steepness of its grades.[54]

THE TECHNOLOGY OF THE SUTTER STREET RAILROAD
The conduits used by the Sutter Street Railroad marked no real advance in cable traction technology from those used by Hallidie. Casebolt and Hovey

[53]San Francisco Call (13 November 1888).
[54]Hilton, pp. 187-88.

designed the original installation along the lines adopted by Hallidie on the Clay Street Hill Railroad, using large quantities of wood in order to keep construction costs at a minimum.[55] In 1879 the firm adopted a yoke of bent railroad iron, modeled after that designed by Henry Root in 1877 for the California Street Cable Railroad.[56] During the 1890-91 reconstruction of the line, new conduit was installed consisting of square wrought iron yokes embedded in Portland cement. This supported 46-pound rails set at a 5-foot gauge.[57]

During the relocation of the powerhouse and extension of the Larkin Street line across Market in 1883, the firm built the first pull curves used in San Francisco. George Duncan invented the pull curve in 1881 for the Dunedin & Roslyn Tramway Co. of Dunedin, New Zealand.[58] Prior to this date existing technology restricted the operation of cable railroads to straight lines, except in special cases like that of San Francisco's Presidio & Ferries Railway, which in 1880 built a drift curve that allowed cars to release the cable and simply coast through the turn. This type of construction proved possible only where both streets involved descended as they approached the intersection.

Pull curves did not require specific street conditions but could be built at any intersection. This advantage over the drift curve resulted in their use for most of the turns built by cable railroads, despite their technical complexity, complicated construction and high cost. A series of horizontal pulleys guided the cable through the turn. A chafing bar, located above and just to the outside of these pulleys, prevented the grip from striking the pulleys and reduced the lateral strain on the grip shank exerted by the pull of the cable. As a car approached a pull curve a slight reverse curve positioned the grip, which pulled the cable up and away from its normal resting place against the pulleys, outside the chafing bar. The car proceeded around the turn at full grip, traveling at the speed of the cable.[59]

The Sutter Street Railroad built six pull curves in conjunction with its 1883 expansion. A contemporary newspaper marvelled at the "bold curve" across Market Street which the cars would negotiate at the full speed of the cable. Ten 5-foot diameter pulleys guided the cable through the two curves at this intersection. At the other turns on the line, which had radii of between forty and fifty feet, 20-inch pulleys set three feet apart in concrete vaults carried the cable.[60]

[55] Smith, p. 42.
[56] Root, p. 50.
Smith, p. 42.
[57] Mining and Scientific Press, 51 (18 July 1885), p. 35.
Hilton, p. 187.
[58] Street Railway Journal, 9 (June 1893), p. 393.
Hilton, p.29.
[59] Hilton, p. 117.
[60] San Francisco Cable Car Days, 1880-89, microfilm in San Francisco Public Library Special Collections, p. 49.

The grip used by the Sutter Street Railroad represented that company's most important contribution to the industry. Hovey and T. Day, the chief engineers of the line, designed the grip, the first to take the cable from the side. Hallidie and Eppelsheimer's grip employed horizontally moving jaws which the cable entered from below, while Hovey and Day's used vertically moving jaws which took the cable from the side. The Sutter Street Railroad grip abandoned the screw-within-a-screw principle of Hallidie and Eppelsheimer, using instead a lever and quadrant arrangement to transfer the gripman's motion to the jaws.[61]

Hovey's first grip design, used a combination of rollers and brakes designed by Colonel W.H. Paine instead of jaws. Hovey tested this design on the Sutter Street line during the summer of 1876, but it quickly proved unsatisfactory. Instead of simply grasping the cable the rollers acted like the dies of a rolling mill, stretching and lengthening the cable, and ultimately breaking its wires. With heavily loaded cars the gripmen simply could not exert enough force upon the lever to prevent the cable from slipping through the rollers. Within six months Hovey and Day substituted jaws for the roller/brake combination, resolving the problem.[62]

The Hovey and Day grip eliminated the need for turntables at the ends of the line. The gripman changed his position, pulling back on the lever eastbound and pushing it forward westbound. By inconveniencing the gripman in this manner it proved unnecessary to turn the dummies around at the termini, and the Sutter Street Railroad used simple switches to change its cars from one track to the other.[63]

A side grip could not be lowered onto the cable like the bottom grip used on the Clay Street Hill Railroad. In order for the grip to take the cable a sheave in the conduit raised the cable to the level of the jaws and then, by means of a lateral deflection in the roadbed, the car and grip were moved onto the cable. The special construction required to move the cable into the jaws of the side grip made it less flexible than the bottom grip, Nevertheless, most lines preferred side grips because of their firmer hold upon the cable. Hovey and Day's side grip, built for a line without any curves, proved too lightly constructed for widespread use among cable traction companies. Even so, it became the progenitor of all future side grips, with its lever and quadrant arrangement being used on nearly every grip designed after 1877. In 1881 Hovey modified the side grip developed by Day and himself for use on the Chicago City Railway. This improved version of the Sutter Street grip became the most popular in the industry for several years.[64]

[61] Smith, pp. 46-47.
[62] Mining and Scientific Press, 52 (9 January, 1886), p. 24.
[63] Hilton, p. 187.
[64] Hilton, pp. 54-55, 235.
Mining and Scientific Press, 51 (18 July 1885), p. 38.
Charles Smallwood, Warren Edward Miller, and Don DeNevi, The Cable Car Book (Millbrae, California: 1980), p. 31.

The powerhouse of the Sutter Street Railroad also differed substantially from that of the Clay Street Hill Railroad. The line's first powerhouse stood at the corner of Bush and Larkin. Four steam engines, each with a 12-inch bore and a 24-inch stroke, drove the three cables run out of the building in 1881. A second powerhouse, built in 1879 at Sutter and Presidio, drove the western end of the Sutter Street cable, which was apparently too long to be operated solely out of the main powerhouse. Two 12"x24" steam engines, built by Prescott, Scott & Co's. Union Iron Works in San Francisco, drove this cable, which ran east from the powerhouse to Buchanan Street. Six boilers, all 16 feet long and varying in diameter from 48 to 54 inches, supplied the steam for the firm's engines in 1883. In 1881 the boilers consumed about twelve tons of coal in the course of nineteen and a half hours of daily operation.[65]

The firm consolidated all its cable driving operations into a single powerhouse, located at the southeast corner of Polk and Sutter, in 1883. As was common with most of San Francisco's cable traction companies, the steam engines, boilers, and winding machinery occupied the building's basement, while the upper floors were used for car storage and repair and offices.[66]

Two pairs of cross compound, non-condensing 500hp steam engines drove the winding machinery in the new powerhouse. The two pair of engines, only one of which operated at a time, ran at 61 rpm under 110 pounds of steam furnished by six 100hp tubular boilers built by the Union Iron Works. A rope drive transmitted power from the engines to a 25-foot diameter receiving pulley mounted on one of the main driving shafts, located 42 feet away across the powerhouse. A set of 12-foot diameter, helical-toothed gears connected this first shaft with a second.[67]

Casebolt and Hovey developed a new driving system for the Sutter Street Railroad in order to avoid the patents held by Hallidie upon the system used by the Clay Street Hill Railroad. It is unclear whether or not the installation used in the 1883 powerhouse employed the same driving system used in the original powerhouse. In the 1883 installation two driving sheaves, also known as winders, drove each cable. The adhesion necessary to avoid slipping was obtained by wrapping the cable around the winders in a figure-eight pattern. The sheaves were mounted in line with each other on the two main shafts. In 1883 the Sutter Street Railroad used one set of 12-foot diameter winders and two sets measuring 10 feet 10 inches in diameter. Some controversy exists as to the winding system used by the Sutter Street Railroad. J. Bucknall Smith, a generally reliable source, claims that the firm used multiple wraps of the cable around a driving and an idler drum to provide the needed adhesion. George Hilton, the most distinguished modern historian of cable traction, accepts Smith's view, but several other contemporary

65 Hilton, p. 187.
Mining and Scientific Press, 43 (3 September 1881), p. 158.
Smith, p. 43.

66 Street Railway Journal, 9 (June 1893), p. 393.

67 Street Railway Journal 9 (June 1893), pp. 393-94.

sources indicate that the line used the figure-eight system described here, also known as the "American" drive system.[68]

In 1883 the Sutter Street Railroad also used a different method for maintaining tension on the cable from that developed by Hallidie. From the winders the cable passed around a vertical tension sheave mounted on a wheeled carriage running on rails. Weights, hanging suspended over a pit and attached by a chain to each tension carriage, pulled the carriages back along the rails as the cable's length varied, keeping it taut.[69]

The surviving descriptions of the Sutter Street Railroad's powerhouse all refer to the building erected in 1883, by which date several other cable traction firms were operating in San Francisco. The details of the firm's original installation are unknown, and it is unclear whether or not the company introduced the figure-eight drive system and moveable tension carriages used in the 1883 powerhouse. They may instead have been adopted after other lines demonstrated their practicality.

The physical plant of the Sutter Street Railroad, designed to circumvent the patents held by Andrew S. Hallidie, made several valuable contributions to cable traction technology. The most important of these contributions, Hovey and Day's side grip, differed radically from the device used by the Clay Street Hill Railroad, and introduced the lever and quadrant motion used on nearly every grip developed after this time. In 1883 the company introduced the pull curve, invented in New Zealand, to San Francisco, freeing the cable car from the restriction of straight line operations. It is unclear, however whether or not the Sutter Street Railroad made any substantial contribution to powerhouse technology, since no descriptions of the original drive system survive. The figure-eight drive system and moveable tension carriages used in the 1883 powerhouse represented marked advances in cable technology, but both appeared in the powerhouses of other firms prior to 1883; the role of the Sutter Street Railroad in pioneering their use is uncertain.

THE CALIFORNIA STREET CABLE RAILROAD

Leland Stanford, one of the "Big Four" entrepreneurs responsible for the construction of the Central Pacific Railroad, financed the construction of San Francisco's third cable line, the California Street Cable Railroad. Impressed

[68] Sutter Street Railroad, Powerhouse Drawings, 1883, California Historical Society Library, San Francisco, California.
Street Railway Journal, 9 (June 1893), p. 394.
Transactions of the Technical Society of the Pacific Coast, vol. 1, num. 3 (July-September 1884), p. 110.
Mining and Scientific Press, 43 (3 September 1881), p. 35.
Hilton, p. 137.
Smith, pp. 45-46.
[69] Mining and Scientific Press, 43 (3 September 1881), p. 35.

by the financial and technical success of Hallidie's Clay Street Hill Railroad, Stanford determined to build a route up California Street past the palatial mansion he had begun building in 1874.[70]

Stanford, Mark Hopkins, another of the "Big Four," commission merchant Louis Sloss and several other prominent San Francisco businessmen, together incorporated the California Street Cable Railroad Co., capitalized at $500,000. They received a franchise for their project on 14 July 1876. Most of the new firm's financial burdens fell on Stanford's shoulders. He purchased 4750 of the 5000 shares offered for sale, his associates, for the most part, lent only their names to the venture, fearful that it would never earn a profit through the collection of nickel fares. Stanford turned over responsibility for designing the line to Henry Root, an assistant engineer with the Central Pacific. Root, who became one of the most important engineers in the cable traction industry, estimated the cost to construct a cable route along California from Kearny to Fillmore at $350,000.[71]

Hallidie demanded $40,000 and final approval of the firm's construction plans for the rights to his patents. Stanford instructed Root to build the best road possible, claiming he would pay the costs if it infringed on Hallidie's patents. Despite Root's efforts to design the line without infringing upon these patents, Stanford was still forced to pay Hallidie $30,000 in patent license fees.[72]

Construction started on 5 July 1877. The route was to consist of 1.7 miles of narrow gauge (3-foot 6-inch) track running on both sides of California from Kearny Street, downtown, over Nob Hill to Fillmore Street in the Western Addition. The construction of the route, which cost $430,000, took only five months, however problems with hot boxes in the engine bearings delayed the opening of the line until 10 April 1878. In its first day of operation the new route carried over 11,000 passengers.[73]

In the spring of 1879 the firm extended its line from about 150 feet west of Fillmore to Presidio Avenue. Stanford wanted to pay for the construction of this short extension out of the line's earnings in order to avoid the incurrance of a debt or a lapse in the payment of dividends to the line's stockholders. Root designed the extension with inexpensive wooden yokes and a plank roadway in order to meet Stanford's desires. The extension opened for service on 30 May 1879, but its had to be completely rebuilt with concrete conduit and iron yokes in 1884.[74]

[70]Root, pp. 35, 61.
[71]Kahn, pp. 45, 48.
Root, p. 43.
[72]Kahn, p.49.
Root, pp. 42-43, 54.
[73]Kahn, p. 48.
Root, p. 45.
San Francisco Morning Call (12 April 1878).
[74]Hilton, p. 193.

Stanford sold his interest in the company to a syndicate headed by local banker Antoine Borel in 1884. In association with company president James B. Stetson, Borel inaugurated an extensive program of improvement and expansion. Installing new machinery in the powerhouse at Larkin and California in 1887 reduced the length of a trip from one end of the line to the other from 21.5 minutes to 18 minutes.[75]

In 1889 Borel and Stetson laid plans for extending the mainline east on California from Kearny to Market, and for constructing a crosstown line running on O'Farrell, Jones, and Hyde Streets. Financing for these projects came from the sale of $950,000 worth of 6% first mortgage bonds on the property. The half-mile long extension on California opened in 1890, and the O'Farrell-Jones-Hyde line, whose construction necessitated moving the company's powerhouse to the corner of California and Hyde, began service on 9 February 1891. The route was the last cable line built in San Francisco.[76]

Unlike other cable lines that gave way to electric trolleys, California Cable operated profitably for many years. The steep grades over which it operated precluded conversion to electric trolleys. Following the earthquake and fire of April 1906, which destroyed all 52 of the company's cars, the firm rebuilt its entire system. This was accomplished despite the fact that the Fireman's Fund Insurance Co., which held a substantial share of the company's stock, was able to pay only about 50% of the $177,000 of damage claims. Restoration of service following the earthquake and fire was not complete until July 1908, over two years after the disaster.[77]

The large traction companies that dominated San Francisco's street railways in the twentieth century never acquired California Cable, which remained independent longer than any of the other cable traction companies in the city. The Market Street Railway, the largest traction company in San Francisco, obtained 1000 shares of stock in California Cable from the Fireman's Fund Insurance Co. in 1907, intending to eliminate the competing firm, but changed its plans and sold the stock in 1917.[78]

The company proved financially rewarding to its stockholders. In 1940 the company president estimated that $600 worth of dividends had been paid out on every share of company stock, which originally sold for $60. In addition to

[75] Root, p. 46.
Hilton, p. 193.
Kahn, p. 57.
San Francisco Morning Call (25 April 1887).

[76] Root, p. 47.
Kahn, pp. 59-60.
Hilton, p. 193.

[77] Hilton, p. 196.
Kahn, pp. 94-95.
San Francisco Morning Call (25 June 1906).

[78] Hilton, p. 197.
Kahn, p. 110.

these dividends the firm had also completely retired the $960,000 debt incurred during the construction of the O'Farrell-Jones-Hyde line in 1890-91.[79]

The cancellation of the company's insurance policy following an adverse legal decision in 1951, forced the company to cease operations on 31 July 1951. The City and County of San Francisco purchased the entire property for a mere $138,000, and reopened the lines on 13 January 1952. The high operating costs of the lines resulted in their running at a loss. In an effort to minimize these losses the city's Municipal Railway, which operated the property, discontinued the O'Farrell-Jones-Hyde line and cut the California line back from Presidio to Van Ness Avenue in May 1954.

In 1956-57 the city consolidated the old California Cable operations into its other cable powerhouse, the structure that still stands at Washington and Mason Streets. The California Street line reopened on 27 December 1957, nearly ten months after the resumption of service on a portion of the old Hyde Street line.

THE TECHNOLOGY OF THE CALIFORNIA STREET CABLE RAILROAD
Root contributed several major innovations to cable traction technology in his designs for the California Street Cable Railroad. Perhaps the most important of these involved the use of wrought iron yokes set in a concrete conduit to form a solid underground structure that enclosed the cable and supported the tracks. Root later admitted that while construction of the line did not constitute "an epoch making event in railroad transportation," it represented exactly that in terms of its "use of concrete construction," being "the first use of a structure made up of wrought metal buried in concrete and moulded to form in place."[80]

Root salvaged discarded 60-pound Tee rails, had them bent to shape, and used them as yokes in the installation. Placed four feet apart, these yokes formed the basic shape of the conduit. Root used Rosendale cement, which was less expensive than imported Portland cement, to encase the yokes and form the sidewalls of the conduit. The cement was poured against a removable wooden form which preserved the shape of the 22-inch deep tube.[81]

The rails used by "Cal Cable" also represented an advance over the simple Tee rails generally employed by earlier lines. Root designed a 36.5-pound girder rail specially rolled for Cal Cable by the Cambria Iron Works of Johnstown Pennsylvania. The officials at Cambria initially refused to roll these rails, citing the expense involved in producing such a small special order, but relented when C.E. Huntington, one of Stanford's business partners in the Southern Pacific Railroad, threatened to take that firm's business elsewhere

[79] Hilton, p. 197.
[80] Root, p. 52.
[81] Smith, p. 49.
Root, pp. 46, 52.
Engineering News, 5 (4 April 1878), p. 105.

unless Root received his rails. Cambria produced the rails, which continued in service until 1909, for $20,000, the only portion of the line's construction funds spent outside California.[82] The paving between the narrow gauge rails consisted of basalt blocks grouted with Portland cement, a substantial improvement over the wooden planking used on the first cable lines.

The construction of the O'Farrell-Jones-Hyde line, supervised by C.H. Holmes, utilized the same basic type of conduit as that on California Street, except that riveted iron members were substituted for the worn Tee rails used as yokes in the original construction. The new line employed a centered slot, for use with the Eppelsheimer bottom grip, instead of the offset slot found on California Street. The Pacific Rolling Mills, a local firm in which Antoine Borel, principal owner of California Cable at the time of the extension, had extensive interests, rolled the slot and track rails used on the new line.[83]

The firm's original powerhouse, a 70'x80', three-story structure standing on the southeast corner of California and Larkin, drove two cables, one running east to Kearny and the other west to Fillmore (later to Presidio). The engines and boilers occupied the building's basement, while the winding machinery sat in a 110'x30' vault located 31' underneath the center of California Street. A shaft 30' long, and 9.5" in diameter connected the engines to the winding machinery.[84]

Wallace W. Hanscom's Hope Iron Works built the two vertical, marine-type steam engines that drove the cable.[85] In 1887 J. Bucknall Smith, an English civil engineer, criticized the engines, which cost over $15,000, complaining that vertical engines were "scarcely suitable" for cable traction because the vibration of the engines could be "distinctly felt when travelling upon the line."[86] Three horizontal, multi-tubular boilers, built by the San Francisco-based firm of McAfee, Spiers & Co., supplied steam for the engines. Daily operation of these boilers in 1887 required nearly eight tons of coal.[87]

[82] Root, pp. 44, 46-47.
Kahn, p. 49.
[83] Street Railway Journal, 9 (June 1893), p. 382.
Daily Alta Californian (21 July 1889).
[84] Engineering News, 5 (4 April 1878), p. 106.
[85] These engines measured 22"x36", and operated at 90rpm. The flywheel measured 9 feet in diameter and weighed 6 tons.
Mining and Scientific Press, (17 November 1877), p. 312.
[86] Smith, p. 50.
Root, p. 45.
Mining and Scientific Press, (17 November 1877), p. 312.
Mining and Scientific Press, 51 (18 July 1885), p. 33.
[87] These boilers measured 57"x12', and supplied an average of 70 pounds of steam for the engines.
Root, p. 45.
Smith, p. 49.
Engineering News, 5 (4 April 1878), p. 106.

The major contribution of the California Street Cable Railroad to powerhouse technology consisted of the placement of the winding machinery, built by William H. Birch's California Machine Works, in the vault under California. This eliminated one of the major sources of cable wear, their deflection and out of the powerhouse. The firm possibly introduced the figure-eight drive system, described for the Sutter Street Railroad, to the industry. It is impossible to verify whether or not credit for this major improvement in cable winding technology belongs to Root, because the nature of the original drive system of the Sutter Street road remains a mystery. The tension apparatus used by Root definitely did not mark an advance in cable technology. As early as 1887 Smith described it as "primitive, if not undesirable." It consisted of a reversing sheave, mounted on a truck loaded with scrap iron, which ran on rails set on a 30 degree slope. The weight of the scrap iron pulled the car, and its sheave, down the incline as the cable stretched, keeping it taut.[88]

The firm replaced the gearing that connected the engine shaft with the drive shaft in 1887. The new gears increased the speed of the cable, and allowed cars to traverse the 26 blocks of the road in 21.5 instead of 18 minutes.[89]

California Cable erected a new powerhouse at the southwest corner of California and Hyde in 1891, a move necessitated by the building of the O'Farrell-Jones-Hyde line. J.C.H. Stutt, a local engineer, designed the powerhouse installation and the Union Iron Works built the engines and other machinery.[90]

The three-story brick powerhouse did not include the 22'x80' lot situated exactly at the southwest corner of the intersection. When the owner of this property discovered that a cable traction company wanted his land for a powerhouse he held out for the "stupendous figure" of $870 a front foot, believing the company would be forced to meet his price. Instead, California Cable bought the rest of the property it desired for about $325 a front foot, and simply built its powerhouse around the holdout, rendering his property virtually worthless.[91]

The steam engines installed in the new powerhouse marked the first use of triple expansion engines for cable traction. Three condensing engines, coupled to a single shaft, produced 500hp at 61rpm. Three 120hp Babcock & Wilcox boilers, only two of which operated at any one time, provided steam for the engines.[92] The company replaced the steam engines with electric motors in

[88]Root, p. 45.
Smith, pp. 50-51.
Engineering News, 5 (4 April 1878), p. 106.
[89]San Francisco Morning Call (25 April 1887).
[90]Root, p. 47.
[91]San Francisco Chronicle (2 November 1889).
[92]The three engines had bores of 14, 20, and 34 inches, and a 54-inch stroke. Street Railway Journal, 9 (June 1893), pp. 379-80.

1916.[93]

In place of gearing, the new powerplant utilized a rope drive to transmit power from a 7' 9" driving pinion on the engine shaft to a 25-foot diameter receiving pulley on the main drive shaft. The main shaft carried two sets of 12-foot diameter winding sheaves. Stutt designed a multiple-wrap driving system for the powerhouse, in which the cable passed around the driving and idler drums four or five times in order to acquire the adhesion needed to prevent the cable from slipping. Up to 300 feet of cable could be taken up by moving the idler drums along a 30-foot long bedplate as the cable stretched with use. Stutt developed an innovative, vertical tension run for the powerhouse, eliminating the need for the long tension runs used by other firms. Stutt's design employed an 8-foot diameter sheave, supported in a gate frame, which bore down on the cable with a weight of 1800 pounds. The weight of the sheave kept the cable taut during the variations incurred during daily operation.[94]

California Cable used two different types of grips on its cars. On the California Street route the firm employed a side grip designed by Root, which operated in essentially the same manner as the Hovey and Day grip used on the Sutter Street Railroad. On the O'Farrell-Jones-Hyde line the need to drop the cable 22 times during the course of a round trip forced the company to adopt the Eppelsheimer bottom grip, first used by the Geary Street Park & Ocean Railroad in 1880. Retaking the cable with a bottom grip required only a small dip in the roadbed to bring the grip down onto the cable, a much simpler process than with side grips, which required a sheave to raise the cable to the level of the grip and a deflection of the track to move the grip onto the cable.[95]

The line's first cars, built in 1877 by the Central Pacific Shops in Sacramento and the Kimball Manufacturing Co. in San Francisco, followed the period's standard practice of using a dummy and trailer. Root developed the combination car, which incorporated the dummy and trailer into a single vehicle, in 1883 for the Market Street Cable Railway. In 1888 Cal Cable adopted double-ended combination-type cars, also invented by Root. California Cable's 30-foot long, 11,200-pound cars, built by the John Hammond Car Co., could be operated from either end by means of duplicate grip levers linked to the grip by connecting rods. Unlike the Market Street cars, which had to be reversed on a turntable at the end of the line, the California-type cars simply passed through a switch onto the opposite track, where the gripman disconnected his grip lever, moved to the opposite end of the car, connected the grip lever at that end, an started on the return trip. This system enabled the company to continue using its termini switches, saving the expense of replacing them with turntables. These double-ended combination cars are still used on the California Street line of the existing San Francisco cable

[93] San Francisco Chronicle (12 January 1916).
[94] Street Railway Journal, 9 (June 1893), pp. 380-81.
[95] Hilton, p. 66.

system.[96]

In 1956-57 the San Francisco Municipal Railway rerouted the California Street cable into its powerhouse at Washington and Mason Streets and abandoned the old California Street Cable Railroad powerhouse. To incorporate the Cal Cable routes into its existing cable system MUNI converted the California Street line to a centered slot compatible with the Eppelsheimer bottom grip used on its other routes. Aside from this change and the rerouting of the cable required to bring it into the Washington and Mason Street powerhouse, most of the trackway of the former California Street Cable lines remains constructed in its original manner.

THE GEARY STREET PARK & OCEAN RAILROAD
Chartered in November 1878, the Geary Street Park & Ocean Railroad, San Francisco's fourth cable traction company, began temporary horsecar service over its routes in August 1879, initiating cable service in February 1880. The cable route ran from Market to Central (now Presidio) Avenue along Geary Street, one of the city's major east-west thoroughfares. Charles F. Crocker, the son of Central Pacific Railroad mogul Charles Crocker, provided most of the $275,000 required for the construction of the line which encountered neither significant grades nor turns in its route.[97]

The company proved financially successful from the outset, a fact which prompted the Market Street Cable Railway to purchase the firm in 1887. Market Street Cable operated the lines separately from its own system, retaining the original name. In 1892 the company extended the tracks west 1.9 miles to Golden Gate Park, simultaneously rebuilding the original line with more permanent conduit and standard gauge track. This conversion to standard gauge allowed the Market Street Cable Railway's cars to operate over the line, making possible through-service from the Ferry Building at the foot of Market to Golden Gate Park.[98]

The city franchise for the route expired in November 1903, and for the next 10 years the company operated under a special arrangement which required it to turn over 10% (later reduced to 5%) of its earnings to the city.[99] The Geary Street Park & Ocean survived the earthquake and fire of April 1906 comparatively unscathed and resumed service on 22 June 1906.[100]

The San Francisco Municipal Railway began erecting overhead streetcar wires along the route in June 1911. Cable operations ceased on 5 May 1912, and on 28 December 1912 the line reopened as the first of MUNI's streetcar

[96]Kahn, p. 50.
Root, p. 48.
Smallwood, et.al., pp. 32, 35.
[97]Kahn, p. 42.
Hilton, p. 201.
[98]Hilton, p. 201.
[99]Root, p. 81.
[100]San Francisco <u>Morning Call</u> (21 June 1906).

operations.[101]

THE TECHNOLOGY OF THE GEARY STREET PARK & OCEAN RAILROAD

With the exception of the Eppelsheimer bottom grip, which is in use today on San Francisco's cable cars, the Geary Street Park & Ocean contributed little to the development of cable traction. William Eppelsheimer, Hallidie's draftsman and collaborator on the Clay Street Hill Railroad, designed the 5-foot gauge Geary Street Park & Ocean with yokes and other track elements of wood. The line operated over grades so slight that it did not require depression pulleys. Considering Root's extensive use of concrete during the construction of the California Street Cable Railroad three years previously, this use of wood amounted to a backward step in cable traction technology.[102]

During the 1892 extension of the tracks to Golden Gate Park the company rebuilt its entire system, replacing its wooden yokes and conduit with cast iron yokes and concrete conduit and reducing the track gauge to the standard 4-foot 8.5-inch gauge. The company also rebuilt its slot rails to accomodate the Root side-grip used on the Market Street Cable Railway's cars.[103]

The firm's powerhouse at the northeast corner of Geary and Buchanan, like much of the rest of the line, was built of wood. Two cables were operated from the building, driven by two horizontal, 250hp O'Neill-type steam engines, built by the Union Iron Works and supplied with steam by three steel boilers.[104] A rope drive connected an 8-foot diameter driving pinion on the engine shaft to a 20-foot diameter receiving pulley on the main shaft. The firm employed the multiple-wrap system to drive its cables.[105]

The bottom grip designed for the Geary Street Park & Ocean represented the line's most important technical contribution to the industry. This grip used the standard lever and quadrant-type linkage to lower a plate which forced the grip's jaws against a pair of stationary rollers. These rollers forced the jaws inwards against the cable. This grip is presently the only type of grip used on the San Francisco cable railroad system. Market Street Cable replaced the Eppelsheimer grips with their own Root single-jaw side grips during the course of the 1892 reconstruction. The line continued to use the Root grips until it ceased operations in 1912.

[101] Hilton, p. 202.
[102] Hilton, p.201.
Smith, pp. 56-57.
Mining and Scientific Press, 51 (18 July 1885), p. 35.
[103] Root, p. 79.
[104] The steam engines had bores of 18 inches and strokes of 48 inches. The boilers, which supplied 65 pounds of steam, measured 52"x16'.
Smith, p. 60.
Street Railway Journal, 9 (June 1893), pp. 387-88.
Mining and Scientific Press, 43 (3 September 1881), p. 158.
[105] Smith, p. 60.
Street Railway Journal, 9 (June 1893), pp. 387-88.

THE PRESIDIO & FERRIES RAILROAD

The Presidio & Ferries Railroad ran primarily on Union Street. It marked the first assault upon Russian Hill, just north of Nob Hill, by cable car. Hallidie served as president of the firm, organized in October 1878. Both Joseph Britton and James Moffitt, partners with Hallidie in the Clay Street Hill Railroad, invested in the new firm, as did Antoine Borel, who purchased Stanford's interests in the California Street Cable Railroad in 1884.[106]

The firm's nearly two miles of 5-foot gauge track was built at a cost of $190,000, and opened for revenue service on 23 October 1880. The line extended from Columbus and Montgomery, where a horsecar line linked the cable tracks to the Ferry Building, north on Columbus and west on Union to Steiner Street. From there a steam line continued out to the Presidio.[107]

A group of local businessmen, including commission merchant George A. Newhall and real estate man A.D. Sharon, purchased the line from the Hallidie interests in the early 1890's, and placed J.C.H. Stutt in charge of two projects: the design of improvements to the existing system and a one-mile extension running along Union, Baker, and Lombard Streets to the Presidio. This extension opened for service in 1892.[108]

The Presidio & Ferries Railroad suffered more damage than any other San Francisco cable route during the earthquake and fire in April 1906. After the disaster the owners of the company rebuilt the system as an electric streetcar line. This line continued in operation as a private company until 1913, when the San Francisco Municipal Railway purchased the firm.[109]

THE TECHNOLOGY OF THE PRESIDIO & FERRIES RAILROAD

The Presidio & Ferries Railroad represented an extremely conservative approach to cable traction. Chief Engineer W.H. Milliken, who served as superintendent of the California Street Cable Railroad in 1878, designed the Presidio & Ferries as a broad-gauge adaptation of Hallidie's original technology.

Prior to 1880 most engineers considered cable cars incapable of negotiating any type of turn. At the intersection of Columbus and Union the Presidio & Ferries Railroad proved this assumption false by building the first curve ever constructed for a cable railroad. Both Union and Columbus ran downhill as they approached the intersection, from the west and south respectively, and Milliken took advantage of this fortunate circumstance in designing his curve. The cable passed around the turn on two 8-foot diameter horizontal sheaves, laid under the pavement beyond the line of the tracks. As cars

[106] Kahn, p. 42.
San Francisco Cable Car Days: 1880-1889, p. 17. Microfilm located in Special Collections Department, San Francisco Public Library.
[107] Kahn, p. 42.
Smith, p. 64.
Hilton, p. 205.
[108] Hilton, pp. 205-06.
[109] *Ibid.*, p. 206.

approached the curve they released the cable and coasted through the 50-foot long turn under their own momentum, retaking the cable at the far side of the curve.[110]

While Milliken's curve, known as a "drift" or "let-go" curve, freed the cable car from the restriction of straight line operations, it did not prove completely successful from the start. Contemporary newspaper reports indicate that the cars often came to a stop before they completely rounded the turn, forcing the crews to push them forward to a point where the grip could retake the cable.[111]

The Presidio & Ferries' powerhouse, located at the southeast corner of Union and Hyde, represented the industry's most extreme example of a firm placing its powerhouse at the highest point on the line. Locating the powerhouse at the line's summit lessened the strain of the cable on the terminal sheaves, but greatly increased the difficulty of hauling fuel and new cables to the building.

Milliken designed the firm's winding machinery to use the grip pulley drive system first employed by Hallidie. The Fulton Iron Works, operated by the firm of Hinckley, Spiers & Hayes, built the 300hp Corliss-type cross compound steam engine used to drive the winders and the three 150hp multi-tubular boilers that provided steam for the engines. Leather belting transmitted power from an 8-foot diameter pinion located on the engine shaft to a 25-foot diameter receiving pulley on the main shaft. The Golden State & Miners' Iron Works built these pulleys, as well as the two grip pulleys which drove the firm's two cables.[112]

Stutt made several changes in the powerhouse in 1892. He replaced the belt drive between the engine and main shafts with a cotton-rope drive, and he substituted multiple-wrap drivers and idlers for the Hallidie grip pulleys. In addition to these changes Stutt introduced a vertical-type tension apparatus similar to the one he designed in 1891 for the California Street Cable Railroad.[113]

In 1892, while engaged in designing the extension of the Presidio & Ferries tracks to the Presidio, Stutt decided that the Hallidie-type bottom grip used

[110] Smith, p. 65.
San Francisco Cable Car Days: 1880-1889, p. 13. Microfilm located in Special Collections, San Francisco Public Library.
[111] San Francisco Cable Car Days: 1880-1889, p. 25. Microfilm located at Special Collections, San Francisco Public Library.
[112] Ibid., pp. 17, 19.
Street Railway Journal, 9 (June 1893), p. 393.
Smith, p. 66.
The cylinders of the firm's engine had bores of 18 and 24 inches with a 36-inch stroke. The engine operated at 72rpm under 80 pounds of steam supplied by the boilers, which measured 54"x16'.
[113] Street Railway Journal, 9 (June 1893), p. 392.

by the firm would not stand the side strain involved in negotiating the pull curve planned for the corner of Union and Baker. He developed a new type of bottom grip for the line in which the outer jaw remained stationary while the inner jaw moved against the cable. This unique design permitted Stutt to retain the road's off-center slot design.[114]

THE MARKET STREET CABLE RAILWAY

The origins of the Market Street Cable Railway date from a horsecar line established in 1867. On 22 August 1883 the company began operating its first cable line, known locally as the Southern Pacific line because its stockholders included Charles F. Crocker, Leland Stanford, and Henry Huntington. The firm eventually became the largest cable traction company in San Francisco, serving the Mission District, Golden Gate Park, and the Western Addition via five branch lines stemming from the main line on Market Street. The Market Street line travelled over the most important shopping street in the city, sharing the street with eight other street railroad companies, and providing the first direct cable car link to the Ferry Building at the foot of Market.[115]

The Valencia line, which ran on Valencia through the Mission District to 29th Street, opened at the same time as the mainline in August 1883. The Haight and McAllister lines began service later that same year, running west from Market to Golden Gate Park. A separate powerhouse drove the McAllister Street cable.[116] By November 1885, while technically profitable, these three branch lines and the main line earned an average of only $40 a day, $75 on Sundays.[117]

Market Street Cable opened a fourth branch line, running west on Hayes Street from Market to Golden Gate Park, on 26 May 1886. This line, like the McAllister Street line, operated out of its own powerhouse. The firm's fifth and final branch, which ran south on Market to Castro and out Castro to 26th Street, opened in 1887. With the addition of these two lines the earnings of the company increased to an average of between $12,500 and $35,000 a month in 1888, and continued to increase at the rate of $4000-5000 per quarter. After completing the Castro line the company's only constuction activity involved two short extensions of the McAllister line in 1892 and 1902.[118]

In 1893 Leland Stanford, then president of Market Street Cable, arranged a merger which brought Market Street Cable, the Omnibus Railroad & Cable Co., the Ferries & Cliff House Railway, and two horsecar operations together under a single management, known as the Market Street Railway. The three cable

114 Ibid.
Hilton, p. 61.
115 Street Railway Journal, 9 (June 1893), p. 383.
Mining and Scientific Press, 47 (27 October 1883).
116 Mining and Scientific Press, 47 (27 October 1883).
117 Real Estate Circular, 2 (November 1885).
118 Hilton, p. 207.
San Francisco Call (13 November 1888).

traction companies involved in the new company, Market Street Cable, Omnibus Railroad & Cable, and the Ferries & Cliff House, received $13,500,000, $3,000,000, and $1,000,000 respectively in stock in the new firm.[119]

This new firm led the fight by the city's cable traction companies against the incursions of the electric streetcars. Horsecar operators desired conversion of their unprofitable lines to electric operations following the successful demonstration of electric traction by Frank Sprague in Richmond, Virginia in 1888. The large capital investment required for a cable railroad created a vested interest for the owners to strive to protect their expensive, inflexible systems against the incursions of competing electric lines. A propaganda campaign instituted by the Market Street Railway, and the other cable companies, attempted to convince the public of the dangers of overhead trolley lines. In an even more direct fashion, the cable interests bribed the Board of Supervisors into passing an ordinance prohibiting the use of overhead wires.[120]

In 1902 a syndicate of eastern investors calling themselves the United Railroads of San Francisco, acquired ownership of the Market Street Railway, the Sutter Street Railway and two electric streetcar companies. The new firm, owned by the United Railroads Investment Company of San Francisco, a New Jersey holding company backed by the German investment banking firm of Ladenburg, Thalmann & Co., now controlled 260 of the 288 miles of street railroad operating in San Francisco.[121] The firm paid an inflated price for the companies it bought, and then issued $40,000,000 of watered stock to its owners, assuming that earnings would increase as the population of the city grew. To pay dividends on this vast amount of stock required that the firm rationalize its operations in order to increase earnings, and decrease its expenses in order to hold costs down.[122]

Patrick Calhoun, president of the company, realized the need for efficient operation of the firm if he hoped to pay dividends on the watered stock. His plans called for the maintenance of labor costs at as low a level as possible and the conversion of unprofitable cable lines to electric operations. Several factors combined to prevent Calhoun from implementing this program. The need to avoid the stigma of an anti-union reputation in San Francisco, one of the nation's most unionized cities, forced Calhoun to accept the carmen's union, organized in 1901, and substantially increase the wages of carmen in 1902-3. The general public opposition to overhead trolley lines, favored by Calhoun because of their low construction and operating costs, and the provisions of certain street railway franchises restricting their operation to either cable or horsecar lines, blocked wholesale conversion of unprofitable lines to elctric operation. Former mayor James D. Phelan and sugar magnate

[119]Judd Kahn, Imperial San Francisco: Politics and Planning in an American City, 1897-1906 (Lincoln, Nebraska: 1979), p. 110.
[120]Kahn, pp. 111-12.
[121]Electric Railway Journal, 32 (5 September 1908), p. 575.
[122]Kahn (1979), pp. 42, 112.
Walton Bean, Boss Reuf's San Francisco (Berkeley: 1972), pp. 109-110.

Rudolph Spreckels led the public opposition to overhead trolley lines, complaining bitterly against the ugliness of the poles and wires they required. Phelan and Spreckels went so far as to organize the Municipal Street Railways Co. in order to build an electric line utilizing a power source located in a conduit under the street as a demonstration of the practicality of that alternative to trolley operations. It is interesting to note that both men owned property along the Pacific Avenue route of the former Sutter Street Railway, one of the lines Calhoun wanted to convert to trolley operations.[123]

The earthquake and fire of April 1906 presented Calhoun with the perfect opportunity to convert many of the United Railroad lines to electric streetcar operations. He and his subordinates supplied a $200,000 bribe to the Board of Supervisors to guarantee passage of an ordinance permitting electrification of street railways regardless of original franchise stipulations. In order to gain public support for the conversion from cable to electric operations Calhoun claimed that United Railroad's cable lines required complete reconstruction, having suffered $400,000 of damage during the earthquake and fire. Local newspapers accused the firm of delaying restoration of streetcar service in order to modernize its system, since insurance claims filed by the firm totaled only 9% of the amount of damages claimed publicly.[124] Following the earthquake and fire United Railroads retained only those cable lines which operated over grades too steep for electric streetcars. Of the original Market Street Cable Railway, only the Castro Street line south of 18th Street remained a cable route.[125]

The Castro line continued as a cable operation until 6 April 1941, when diesel buses replaced the cars. During the intervening years, United Railroads survived a long, bloody strike by its carmen in 1907, declared bankruptcy in 1918, and reorganized as the second Market Street Railway in 1921. The firm operated under this name until closure of the Castro line in 1941. The other cable routes operated by United Railroads and Market Street Railway, built by earlier firms, continued in operation until 1944, when the San Francisco Municipal Railway bought out the Market Street company.[126]

THE TECHNOLOGY OF THE MARKET STREET CABLE RAILWAY

Market Street Cable operated one of the busiest cable railroads in the entire United States, with cars departing the Ferry Building at 40 second intervals, reduced to 15 seconds during rush hours, and traveling along Market Street at 8mph. A complete trip from the Ferry Building to the end of the Valencia Street line required only 34 minutes, a fact facilitated by the easy route of

[123] Bean, p. 111-13.
Kahn (1979), pp. 112-14.
[124] Bean, p. 134.
[125] Hilton, p. 210.
[126] Hilton, p. 210.

the line, which lacked significant curvature except in the area of the main powerhouse at Market and Valencia, or grades greater than 12%, excluding the 18.4% grade on the Castro Street hill.[127]

Henry Root designed the original Market Street Cable installation, using the bent Tee rail and concrete conduit construction he had developed for use on the California Street Cable Railroad. Root found it neccessary to provide supporting structures for much of the conduit because of the swampy, unstable terrain over which much of the line passed. At 9-foot intervals all along the route work crews excavated to a depth of 10 feet and poured 16"x5' concrete piers to support the conduit. At the lower end of Market, where the line ran across land reclaimed from the bay, driven piles supported the piers. The line contained 9000 of these piers, and included 25,000 yokes, 1000 tons of slot rail, and 43,000 barrels of Portland cement.[128]

Root designed the first beam-mounted depression pulleys used by a cable railroad for the Market Street line. Prior to this time all cable railroads used fixed depression pulleys and a grip with an "L" shaped foot which allowed the grip to pass the pulleys without striking them. Root's depression beam utilized a counterweighted, 6-foot-long horizontal arm which carried the pulleys. This beam swiveled or pivoted out of the way when struck by an approaching grip.[129]

Root also developed a new means for negotiating turns for Market Street Cable. A 400-foot-long auxiliary cable, run off a 6-foot diameter sheave mounted directly on the engine shaft in the main powerhouse at Market and Valencia Streets, pulled the cars around the 55 degree curve from Valencia into Market at half the speed of the main cable. The auxiliary, which was guided around the 120-foot curve by fifteen side-bearing cone pulleys, filled the gap between the points where the Valencia and Market Street cables were deflected into the powerhouse. As cars approached the curve, a lateral deflection in the track allowed the gripman to release the Valencia cable. The car then coasted forward eight feet, picked up the auxiliary cable, and travelled through the turn. At the end of the curve the gripman released the auxiliary and grasped the Market Street cable. Cars running from Market into Valencia negotiated the turn as a simple drift curve.[130]

Root's design for Market Street Cable's turntables also represented a departure from previous cable railroad practice. The 30-foot diameter, double-tracked turntable at the Ferry Building allowed cars to be run on and

[127] Hilton, pp. 208, 210.
Mining and Scientific Press, 47 (27 October 1883), p.268.
[128] Root, p. 54.
Smith, p. 69.
Mining and Scientific Press, 47 (27 October 1883), p. 268.
[129] Smith, p. 71.
Mining and Scientific Press, 47 (27 October 1883), p. 268.
[130] Smith, p. 71.
Mining and Scientific Press, 47 (27 October 1883), p. 269.

off the table at the same time, reducing the amount of time required to reverse the cars. The turntable dispatched cars onto three separate spur tracks, one for each of the company's branch lines in 1883, permitting cars to be dispatched up Market with minimum headway. Because of its size and weight this turntable could not be operated by hand, and Root relied upon the motion of the cable against a series of pulleys to turn the table at 1/5 the speed of the cable.[131]

Market Street Cable's main powerhouse occupied the southeast corner of Market and Valencia. The winding machinery, which utilized the figure-eight drive system, drove the Market, Valencia, Haight, and, later the Castro Street cables. The "American" system, as the figure-eight method was termed, required fewer wraps of the cables around the winding sheaves than the multiple-wrap method of driving, known as the "English" system. Many contemporary engineers felt that fewer wraps meant a longer cable life.[132]

Two pairs of 400hp cross-compound, non-condensing, O'Neill-type steam engines, built by the Union Iron Works, drove the 12-foot diameter winding sheaves, transmitting their power to the main shaft be means of spur gearing. In 1887 these were the only cross-compound steam engines operating a cable railroad in San Francisco. Only one pair of engines operated at a time, the other set being kept in reserve. The engines consisted of four separate engines, linked together in pairs by connecting the bottoms of their cylinders. By 1893 the firm planned to divide the main engine shaft and run both pairs of engines simultaneously, each driving two cables, because of the increase in traffic upon the line. Six Babcock & Wilcox, horizontal, multi-tubular boilers (which the firm claimed were the first Babcock & Wilcox "type" boilers used on the Pacific Coast) supplied 120 pounds of steam to the engines.[133]

For each cable Root employed standard, carriage-type tension devices, each with a suspended, 8000-pound counterweight. The tension runs extended 165 feet back from the winding machinery. These tension carriages closely resembled those now in use in the Washington and Mason Street powerhouse[134]

The McAllister and Hayes Street powerhouses, constructed in 1882 and 1886 respectively, also used the figure-eight drive system. The Hayes Street powerhouse used a 300hp Corliss-type steam engine instead of the O'Neill-type engines used at the line's other powerhouses. Neither of these installations

[131] Smith, p. 73.
Mining and Scientific Press, 47 (27 October 1883), pp. 269-70.

[132] Smith, p. 75.
Mining and Scientific Press, 47 (27 October 1883), p. 265.

[133] The firm's steam engines measured 24"x34"x48". The boilers sat in three batteries, each generating 440hp.
Street Railway Journal, 9 (June 1893), p. 386.
Smith, p. 75.
Mining and Scientific Press, 47 (27 October 1883), p. 265.

[134] Smith, p. 76.
Mining and Scientific Press, 47 (27 October 1883), p. 265.

significantly advanced the technology of cable traction.[135]

In 1883 Root developed a combination-type car, which placed the grip and passengers on a single car instead of separate dummies and trailers, in order to permit conversion of Market Street Cable's old horse cars to cable operations. The Southern Pacific Shops in Sacramento built most of these cars, which ran on two, pivoted trucks, each equipped with both wheel and track brakes, similar to the trucks on standard railroad carriages. Prior to this time all cable cars ran on a single truck. Root's combination cars measured 30 feet in length and weighed 9600 pounds. The grips used by the line, manufactured by the Judson Iron Works and William H. Birch's California Machine Works, represented an improved version of the side-grip developed by Root for the California Street Cable Railroad. The grips were mounted on the forward truck of each car.[136]

Market Street Cable operated more ancilliary facilities than any of the other cable traction companies in San Francisco. A two-story, brick repair building located behind the main powerhouse included an iron working shop and brass foundry in addition to the usual carpentry, painting and repair facilities. In about 1886 the firm undertook the manufacture of its own cable, using a massive machine patented by Root. The firm abandoned the machine about 1893 because it could not produce "Lang lay" cable, an 1881 British invention which wrapped the strands and individual wires of the cable in the same direction. This technique resulted in the wires of the cable presenting a long continuous surface to the jaws of the grip, evenly distributing the pressure of the jaws. As Lang lay cables aged they tended to wear smooth, reducing the chance of broken wires and dangerous strands in the cable.[137]

THE OMNIBUS RAILROAD & CABLE COMPANY

The Omnibus Railroad & Cable Co. operated 11.3 miles of cable railroad, the second largest, but least successful, cable system in San Francisco. The origins of Omnibus Railroad & Cable date back to one of the first transportation companies in the city, the Omnibus Railroad, a horsecar line organized in 1861. In the 1880's the firm's owner, Gustav Sutro, brother of mining entrepreneur Adolph Sutro, undertook a two-year study of the economies of cable and electric traction, and determined to replace the horsecar operations of his firm with a cable system. Unfortunately, Sutro opted for a technology that was to be outdated within five years, as electric streetcars reached a high level of reliability. Eleven years after the opening of the first Omnibus cable route in August 1889, all the firm's routes had been converted to electric operations or abandoned.[138]

135 San Francisco Call (2 June 1886).
136 Mining and Scientific Press, 47 (27 October 1883), pp. 266-67.
137 Street Railway Journal, 9 (June 1893), pp. 386, 388-89.
Hilton, p. 77.
Root, p. 64.
Scientific American Supplement No. 565, 22 (30 October 1886), 9017.
138 Hilton, p. 229.
San Francisco Chronicle (5 March 1945).

The Omnibus cable system largely duplicated the existing routes of the Market Street Cable Railway, except that it ran on less heavily travelled and developed streets. The company never succeeded in generating any substantial traffic for its lines, and failed to ever pay a dividend to its stockholders. In August 1893, after less than four years of operation, the company closed its route on Howard Street, which had run from the powerhouse at 10th Street to 26th Street. Market Street Railway acquired the foundering company in October 1893, and began systematically converting the firm's lines to electric operations or completely eliminating them. The Oak and Ellis routes, operating out of a powerhouse at Oak and Broderick Streets, converted from cable to electric operations at the end of 1895. The mainline, running along Howard from the Ferry Building to the powerhouse at 10th Street, ceased operating altogether, along with the firm's Post Street route, at the close of 1899.[139]

THE TECHNOLOGY OF THE OMNIBUS RAILROAD & CABLE COMPANY

G.W. Douglas served as engineer for the conversion of the firm's 5-foot gauge horsecar tracks to narrow gauge (3-foot 6-inch) cable tracks. The firm used a standard concrete conduit with iron yokes and 51-pound Tee rails. The seven turntables on the line operated in a manner similar to those designed by Root for the Market Street Cable Railway, taking their motion from the cable.[140]

The main powerhouse at Howard and 10th Streets drove three cables, two running on Howard Street, one to the Ferry Building and one to 26th Street, and the Post Street cable, the most torturous route in the entire city. Two pair of 750hp cross-compound O'Neill-type steam engines, supplied with 75 pounds of steam by six 250hp elephant-type tubular boilers, drove the winding machinery, transmitting power from the engine shaft to the main shaft by means of a rope drive.[141]

The line utilized the multiple-wrap drive system, winding the cable five times around the drivers and idlers. The idlers could be moved 56 feet away from the drivers, along a bedplate, in order to take up slack in the cable. A standard, carriage-type tension arrangement compensated for the stretching of the cable, though the tension run measured only 10 feet in length. The normal stretching that occured during the first days of a new cable's use was cut out after a week to ten days, allowing this shorter than usual tension run.[142]

In 1893 Omnibus Railroad & Cable operated 143 combination-type cars, all built by the John Hammond Car Co. in San Francisco. The company used the

[139] Hilton, p. 229.

Street Railway Journal, 12 (February 1896), p. 119.

[140] Street Railway Journal, 9 (June 1893), p. 390.

[141] The line's engines measured 29"x44"x60", and operated at 59rpm. The rope drive ran 44 feet between an 8-foot diameter drive pinion and 24-foot diameter receiving pulley. Elephant boilers were so named because they might be built up to 50 feet in length.

Street Railway Journal, 9 (June 1893), p. 390.

[142] Ibid.

Eppelsheimer bottom grip because it occupied the inferior position at all cable crossings.

THE FERRIES & CLIFF HOUSE RAILWAY

San Francisco's surviving cable car operations are an amalgam of portions of the California Street Cable Railroad and the Ferries & Cliff House Railway. While the California and Hyde Street lines, originally owned by Cal Cable, comprise the major share of the extant track, the Ferries & Cliff House Railway, San Francisco's seventh cable traction company, furnished the heart of the present system, the powerhouse at Washington and Mason Streets, and the Powell-Mason line.

In the mid-1880's Gustav Sutro, owner of the Omnibus Railroad & Cable Co., projected a line of steam dummies and cable cars, called the Park & Cliff House Railway, to run from downtown to the resort area being developed by his brother, mining entrepreneur Adolph Sutro, near Cliff House. Gustav sold his interest in the scheme before it moved beyond the planning stages to W.J. Adams, a sawmill owner and lumber dealer, who was actively promoting a north-south cable route, the Powell Street Railway, up Nob Hill. Adams combined the two projects into the Ferries & Cliff House Railway, although he continued to refer to the line as the Powell Street Railway.[143] Associated with Adams in the venture were William H. Martin and John Ballard, the contractors who built the Clay Street Hill Railroad, Thomas Magee, a real estate man and editor of the influential Real Estate Circular, and Henry H. Lynch, a real estate man who served as superintendent of the Ferries & Cliff House.[144]

The Powell Street line served several important and populous areas of the city largely ignored by the other cable lines. From Powell and Market the Powell Street line, which opened on 28 March 1888, ran north through the fashionable shopping area surrounding Union Square, the elegant residential neighborhoods of Nob Hill, and the largely Italian North Beach section, to the waterfront at Bay and Taylor. The east-west line of the company, in service by 5 April 1888, ran on Washington and Jackson Streets, connecting with a steam line at Central (Presidio) Avenue and Sacramento which continued west to the Cliff House and Sutro Baths. Newspapers projected that this line would open up an "extensive and desirable" region which would furnish homesites for "thousands of... Artisans, merchants and clerks."[145]

Operating these two lines out of a single powerhouse (located at the northwest corner of Washington and Mason Streets) resulted in one of the most complicated cable systems ever constructed. Howard C. Holmes, an engineer with a background in steam railroading, and the designer of the Oakland Cable Railway, drew up the plans for the Ferries & Cliff House system. He also supervised construction of the O'Farrell-Jones-Hyde extension to the

[143] Smallwood, et. al. (1980), p. 41.

[144] Hilton, p. 217.
Real Estate Circular, 22 (September 1887).
Street Railway Journal, 9 (June 1893), p. 395.

[145] San Francisco Chronicle (19 December 1886).

California Street Cable Railroad in 1890, portions of which survive in the present system, and designed the Clay-Sacramento line of the Ferries & Cliff House in 1892.[146]

In September 1887 Adams purchased the Clay Street Hill Railroad for $200,000, considered by local observers to be a high price, in order to secure a route east from Powell to the Ferry Building. The Ferries & Cliff House franchise permitted the line to run along Jackson and Washington to the Ferry Building, but the Omnibus Co. operated horsecars, blocking the route, on both of these streets between Stockton and Montgomery. Any effort to obtain the right-of-way on these streets through the courts would have tied up the route for at least a year. The firm purchased the Clay Street Hill Railroad in order to acquire an uncontested route to the Ferry Building that would enable the cars to operate at a higher speed. Ferries & Cliff House operated the Clay Street route until 1891, when it tore up the original double-track installation and installed a new single set of tracks. After this reconstruction the firm routed cars westbound on Clay to Larkin, crossed over a block to Sacramento, and continued west on Sacramento to Central Avenue. The return to the Ferry Building was entirely on Sacramento. Holmes supervised construction of the 3.4-mile route, which was completed in 1892 in only seventy days. This work included construction of six cable crossings and the extremely complicated cable and trackwork in the vicinity of the powerhouse.[147]

The Ferries & Cliff House Railway incurred a $1,900,000 debt constructing its eight miles of cable road. Historian George Hilton believes the firm had no future as an independent operation, a statement supported by the October 1893 absorption of the firm into the Market Street Railway.[148] The merger resulted in the construction of the one major extension to the former Ferries & Cliff House system. In the fall of 1893 the Market Street Railway undertook to extend the Sacramento line to the site of the Midwinter Fair planned for 1894 at Golden Gate Park. The 1.9-mile long extension, running on Lake Street and 6th Avenue to Golden Gate Park, opened on 15 February 1894. The Market Street Railway's McAllister Street powerhouse drove the 30,500-foot cable used for the extension.

Along with the rest of the Market Street Railway, the Ferries & Cliff House system became part of the United Railroads of San Francisco in 1902. United Railroads discontinued the Sacramento Street cable west of Walnut in 1904, shifting the traffic to their existing electric streetcars.

The earthquake and fire of April 1906 utterly destroyed the powerhouse at Washington and Mason and also ruined much of the line's rolling stock. However, because the period's electric cars could not negotiate the grades they encountered, all three cable lines resumed operation, though in truncated

[146] Root, p. 47.
Hilton, p. 217.
[147] Hilton, p. 217.
Real Estate Circular, 22 (September 1887).
[148] Hilton, p. 220.

form, after the disaster. United Railroads fully restored the Powell-Mason line, cut the Washington-Jackson line back from Central Avenue to Steiner, and cut the Clay-Sacramento line from 6th Avenue to Fillmore. The firm also changed the Clay-Sacramento line so that eastbound cars ran on Clay and westbound cars on Sacramento. This avoided a one block uphill walk for patrons of the Fairmont Hotel who arrived in the city by ferry, and permitted the line to operate with the prevailing traffic flow at the Ferry Building.[149]

The former Ferries & Cliff House system became part of the second Market Street Railway in 1921, following the 1918 bankruptcy of United Railroads. The reduction in ferry traffic and the inroduction of diesel buses led to the elimination of the Clay-Sacramento line on 15 February 1942.

The San Francisco Municipal Railway acquired the old Ferries & Cliff House lines along with the rest of the Market Street Railway in 1944. Mayor Roger Lapham proposed eliminating the remaining cable mileage in January 1947, but public opposition led by the Citizens' Committee to Save the Cable Cars, founded by Friedel Klussman, prevented immediate conversion of the Powell and Sacramento lines to diesel buses. In 1954 Save the Cable Cars finally secured passage of a city charter amendment prohibiting elimination of any of the survivng cable car routes. Between the campaign's start in 1947 and the final victory in seven years later over 50% of the city's cable car lines were removed.[150]

In 1952 the city's Municipal Railway (MUNI) acquired the California Street Cable Railroad lines, incorporating these operations into the Washington and Mason Street powerhouse in 1956-57. The city consolidated its operations by incorporating portions of the O'Farrell-Jones-Hyde line of Cal Cable into the present Hyde Street line. Construction on this work began in 1954, and the new route opened in April 1957. The lines operating at the present time remain unchanged from those in service in April 1957.

THE TECHNOLOGY OF THE FERRIES & CLIFF HOUSE RAILWAY

For the Ferries & Cliff House Railway Howard C. Holmes designed one of the most complex cable systems ever built. He placed the tension runs in the powerhouse on a diagonal because of a lack of space in the building, and directed the cables onto the street through a vault under the building's southeast corner. In order to get the cables in and out of the powerhouse, and to their streets, Holmes relied on several slightly bizarre routes and made extensive use of blind conduit, a tunnel without a slot connecting it to the surface. The west end of the Clay-Sacramento cable, for example, passed through two blocks of blind conduit running east on Washington from the powerhouse to Stockton, and then through another two blocks of blind conduit running south on Stockton from Washington before issuing onto Sacramento. The cable returned to the powerhouse through a block of blind conduit under Mason Street between Clay and Washington.

[149] Ibid.
[150] Save the Cable Cars File, San Francisco Room, San Francisco Public Library.

The complexity of the trackwork around the powerhouse required several novel elements in cable traction technology. On both Washington and Jackson Streets, for the block between Powell and Mason, Holmes designed a roadbed that used two separate conduits, or at least tubes for two separate cables, and only three track rails, the cars sharing the center rail. Cars turning from Mason onto Jackson negotiated the intersection by means of a turntable instead of a pull curve. Holmes adopted a variation of Root's iron and concrete conduit for the entire line, embedding the wrought iron yokes in a brick and earth-fill conduit. Although these arrangements succeeded in moving the cars and cables through the area of the powerhouse, their complexity marked no real advance in cable technology.[151]

The Mahoney Bros., a San Francisco car-building firm owned by Jeremiah and John Mahoney, received the contract to build the company's single-ended cable cars. The Mahoneys subcontracted much of the actual construction of the car bodies to the Burham-Standeford Co.'s Oakland Planing Mills. P.H. McGrew, an Oakland blacksmith, fabricated the cars' trucks and ironwork at a cost of $304 per car.[152]

Holmes adopted the Eppelsheimer bottom grip for use on the line, primarily because a round trip on the Powell line required the gripman to drop the cable 14 times at cable crossings and once for a drift curve, a situation which virtually forced the use of a bottom grip.[153]

The company acquired the powerhouse site at Washington and Mason Streets in October 1886. A stable occupied the site previous to its purchase by the cable traction company.[154] Work began on the foundations by late February 1887, and the company let contracts for the building and machinery in March.[155] By late June 1887 workers had completed the walls of the three-story building up to the level of the second floor. The square brick building measured 137.5'x137.5'. The firm's boilers, engines, and winding machinery occupied the first floor, the upper two floors being devoted to car repair and storage tracks and company offices.

Risdon Iron Works, in San Francisco, built the two original steam engines used

151 Street Railway Journal, 9 (June 1893), p. 395.
152 San Francisco Chronicle (16 July 1951).
153 Hilton, p. 217.
The method of construction used at cable crossings is described in a contemporary newspaper account of the building of the Powell line's crossings at Sutter and Geary. The area around the existing tracks was excavated and the tracks braced with wooden beams. The entire crossing assembly was riveted together on rollers above the crossing. A derrick hoisted the pre-fabricated crossing into place at night, and wooden beams held the whole assembly in place until completion of the paving. San Francisco Chronicle (19 September 1887).
154 Real Estate Circular, 21 (October 1886).
155 San Francisco Chronicle (23 February 1887).
San Francisco Chronicle (18 March 1887).

by the firm, reported by the San Francisco Chronicle to be 600hp Corliss-type engines. Six 16-foot long horizontal, tubular boilers, located in fire pits along the south wall of the building, provided steam for the engines.[156]

For unknown reasons the company replaced these engines in 1889 with two 450hp, horizontal, non-condensing Thompson-type steam engines built by the Golden State & Miners' Iron Works of San Francisco. In 1891 the firm installed two 450hp, vertical, non-condensing Corliss-type steam engines built by John B. Clot and Constant Meese's San Francisco-based Reliance Machine Works. These vertical engines straddled the winding machinery. The company scrapped its original boilers in 1894, replacing them with eight 115hp elephant boilers, built by the Union Iron Works. Arranged in pairs in four batteries, these boilers stood against the west wall of the building, providing 125 pounds of steam to the engines.[157]

The two pairs of engines coupled to separate shafts. Either set of engines and shafting could be used to drive the winding machinery. The shaft for the vertical engines measured 14 inches in diameter and was 26 feet long. A 4-foot 6-inch diameter, helical-toothed drive pinion transmitted the power to a 14-foot diameter bull gear mounted on the first drive shaft. This bull gear meshed with an identical gear mounted on the second drive shaft. The flywheel for the vertical engine measured 15 feet in diameter and weighed 25 tons.[158]

Each of the horizontal engines coupled to one end of an 18-inch diameter shaft carrying another 4-foot 6-inch diameter drive pinion. An eccentric arrangement allowed either drive pinion to be thrown into position against the bull gears, permitting either engine to operate the winding machinery.[159]

In 1893 the Ferries and Cliff House used the figure-eight system to drive the five cables operated out of the powerhouse. Each of the six 14-foot diameter winding sheaves carried two grooves, instead of the usual one, on its rim. Two of the sets of winding sheaves drove two cables each while the third set drove only a single cable, wrapped twice around the sheaves in order to gain additional adhesion. The cables passed from the winding sheaves to standard movable tension carriages, patterned on those designed by Henry Root for the California Street Cable Railroad and the Market Street Cable Railway. In the case of the winders driving two cables, the cables passed to two separate tension carriages, positioned one behind the other on the same set of

[156]The steam engines had a 22-inch bore and an 18-inch stroke. Real Estate Circular, 21 (October 1886).

[157]The horizontal engines had a 24-inch bore and a 48-inch stroke. They operated at 65rpm. The vertical engines, which displayed greater efficiency in their consumption of coal, had a 25-inch stroke, a 44-inch stroke, and operated at 73rpm. The elephant boilers measured 56 inches in diameter and 16 feet long.

United Railroads of San Francisco, Statement, January 1905. Original in possession of Charles Smallwood, San Francisco.

[158]Street Railway Journal, 9 (June 1893), p. 395.

[159]Ibid.

tracks.[160]

In 1902, when United Railroads of San Francisco took over the system, the firm erected a three-story brick annex attached to the north wall of the powerhouse and car barn, increasing the structure's car storage and repair facilities. Like the main building the annex was constructed on a slope, so that the second floor on the east side of the building became the first floor on the west side. The annex measured 46'x131.5' on the ground floor, its upper two stories extended west another 50' to the property line. Portions of the west wall of the annex are still evident in the retaining wall along the west side of the present property.[161]

In 1905 the first floor of the annex contained four sets of east-west oriented tracks, connected by a transfer table at the west end of the building, and a large car elevator used to lift the cars to the repair and storage areas on the second and third floors. Cable cars entered the annex by means of a spur track off the Mason Street line. On the second floor of the building a car could be run off the elevator onto a transfer table along the west side of the floor. This transfer table served fifteen sets of east-west oriented repair and storage tracks. A 24-foot diameter turntable sat in the southwest corner of the floor. This turntable moved cars from the transfer table onto the street through a large doorway cut into the south facade of the building just east of the smokestack.

The third floor of the building contained more repair and storage tracks. Cars were pushed off the elevator onto a transfer table that served four sets of east-west oriented tracks in the annex and a spur track leading to another transfer table oriented along the east-west axis of the main building. This second transfer table served ten sets of north-south oriented tracks in the main building.[162]

The earthquake and fire of April 1906 almost completely destroyed the powerhouse. United Railroads utilized the surviving footings and foundations during construction of the present building, erected during 1907 and 1908 at a cost of $75,000.[163] This two-story brick structure, which stands 48 feet tall, measures 137.5'x180.5' in plan. The brick walls are 21 inches thick at the first floor level, tapering to 17 inches at the second floor. Every sixth course of bricks in the exterior walls is a header course. The concrete slab ground floor has several pits or vaults for the winding machinery, tension runs, deflecting sheaves, boilers and fuel storage. The second floor, supported on steel columns and beams, stands 22 feet above the ground floor and consists of wooden planking. Wooden posts on the second floor support a wooden trussed roof in the main portion of the building. In the "annex" the

[160] Ibid.
[161] United Railroads of San Francisco, Drawings C-1476-78 (28 April 1905). Blueprints in possession of Charles Smallwood, San Francisco.
[162] Ibid.
[163] San Francisco, Department of Public Works, Building Permit No. 6881 (18 December 1906.

roof rests on steel columns and beams. During reconstruction of the building the smokestack, which partially collapsed during the earthquake, was reduced from its original 185-foot height to 89 feet.[164]

United Railroads redesigned the car handling facilities of the building during its reconstruction. A 15,000-pound capacity Otis Elevator Co. car elevator was installed in the "annex" portion of the building to permit transfers of cars between the two floors and to facilitate the movement of the 300-pound grips from the car storage area on the second floor to the grip repair facilities on the first. The new "annex" does not extend back to the property line on its west side, like the original annex, but stops some fifty feet short. A set of tracks laid in this space connects the mainline on Jackson Street to a large turntable located in the yard behind the powerhouse. This turntable connects to the thirteen sets of repair and storage tracks on the building's second floor. The entire west facade of the building is open, permitting cars to be rolled easily onto and off of these tracks.

Incoming cars release the cable on Jackson, above a switch connecting the mainline and the yard spur, and roll backwards into the yard under their own momentum. Stopping on the turntable, the cars are then spotted onto the desired track in the car barn. Outbound cars, are pushed onto the turntable from their storage tracks and sent onto Washington Street by means of another spur connecting the turntable with the street.

The United Railroads rebuilt the steam engines, boilers, and winding machinery damaged by the earthquake and fire and used them when operation of the Powell Street line was renewed in January 1907. Temporary wooden sheds protected the equipment from the weather during reconstruction of the building.[165]

In 1912 United Railroads removed the horizontal steam engines and installed a 600hp, 400rpm General Electric induction motor, connected to the main shaft by a chain and sprocket drive which drove the shaft at about 75rpm. The building received at least a portion of its electricity through a feeder line taken off the company's Kearny Street trolley line. This line entered the building trough the circular conduits still evident above the door at the south end of the Mason Street facade. In conjunction with the electrification of the winding machinery the firm installed a 275kw substation in the powerhouse. Transformers stepped the station's voltage down from 11,000 to 440 volts for use by the motor.[166]

The vertical steam engines remained in the building as a backup system to the electric motor until 1924. In August 1926 the company replaced the vertical engines with the present No. 2 Motor and Reduction Gear, relegating the 1912 installation to a backup status. Motor No. 2 is a 750hp General Electric induction motor operating at 712rpm. It is connected to a single reduction gear, manufactured by the Falk Corporation of Milwaukee, which drives the main

[164] Ibid.
[165] San Francisco Call (12 January 1907).
[166] San Francisco Municipal Railway, Drawing 1109 (21 March 1911).

shaft at 78rpm. Helical-toothed gears transmit the power from the main shaft to the driving shafts.

Incorporation of the California Street Cable Railroad operations into the powerhouse in 1956-57 necessitated a major renovation of the building's mechanical plant. In 1958 the present No. 1 Motor and Reduction Gear replaced the 1912 motor installation. Motor No. 1 is a 700hp Fairbanks Morse induction motor operating at 705rpm. A reduction gear, manufactured by the Western Gear Co. of Los Angeles, transmits the power to the main shaft at 78rpm. The original switchboard, transformers and substation were replaced at this time by the present unit, manufactured by the ITC Circuit Breaker Co. This unit rests on a concrete slab poured over the top of the old boiler pits. The 1958 renovation also involved the installation of the existing 30-ton capacity overhead crane and a new cable rewinder, both used when replacing a worn cable with a new one.

In 1960 Muni closed off the old boiler spaces along the west wall of the first floor with partitions, creating offices and workers' facilities. A major renovation of the winding machinery, costing $277,000 took place during 1965. VOEST, an Austrian firm, built the gears and winding sheaves presently in use. The helical-toothed pinion gear measures 42 inches in diameter and meshes with two inter-meshed 14-foot diameter bull gears that drive the shafts carrying the winding sheaves at 19.2rpm. There are six 14-foot diameter winding sheaves, three mounted on each of the driving shafts. The figure-eight drive system and Root-type, moveable tension carriages remain in use. Replacing the winders and gearing required 28 days of work.[167]

A machine shop occupies the space along the east wall of the powerhouse's first floor. Until about 1970 all of the shop's equipment operated off belt drives powered by small electric motors. Five of the machine tools in the shop date from c.1900 and continue to be belt-driven. The other major machine tools in the shop date from c.1970.

The last major alteration to the powerhouse, the installation of the mezzanine floor in the southern half of the building, was made in 1967. This floor is used as a museum and also provides a viewing platform from which to observe the winding machinery. The southernmost window on the Mason Street facade was converted into a doorway to provide access to this level. Various "period" embellishments, such as a decorative canopy, flower boxes, antique-styled signs, and replicas of gas lamps, date from this alteration of the building and are intended to convey the historical nature of the structure.

The street systems of the old Ferries & Cliff House system have changed relatively little over the years. Bringing the California Cable lines into the system in 1956-57 required rebuilding some track, constructing several new turns, and building a new turntable at the northern terminus of the Hyde Street line. MUNI combined the Powell and Mason cables into a single line in 1977, hoping to economize their operations. However, the new cable, 18,200

[167] San Francisco Chronicle (14 April 1965).

feet in length, is subjected to a greater number of curves which tend to curtail its useful life. MUNI engineers designed all-steel depression beams in 1980, which substituted a universal joint for the counterweight used on the old depression beams. These new beams replaced all the old style depression beams, except those on California Street. They require less maintenance and are more reliable than the old-style beams.

CONCLUSION

The existing San Francisco cable railway system incorporates elements from all periods of cable traction. Many yokes, and much of the conduit, date from the 1870's or 1880's. Portions of the powerhouse are associated with the heyday of cable traction during the late 1880's and early 1890's, while most of the structure reflects the rebuilding of the city following the earthquake and fire in April 1906. The functioning 1926 motor installation is a reminder of the substitution of electricity for steam in cable traction, as are the now-covered boiler pits, unused coal storage bins and smokestack at the powerhouse. The truncated California Street line, ending abruptly at Van Ness Avenue instead of continuing west to Central Avenue, symbolizes the hard times faced by cable traction companies in the 1930's and 1940's, when diesel bus lines supplanted most of the surviving cable mileage. The meandering Powell-Hyde line, with its delightfully illogical route and bravely independent turn across traffic at Beach and Hyde Streets, illustrates the inherent inflexibility of cable traction. Survival of the cable cars in the automobile age requires that the public tolerate this inflexibility, for without such tolerance the last cable lines would have closed years ago.

The motors and rebuilt winding machinery in the powerhouse demonstrate the literal linkages between old and new in the system. Motors No. 1 and 2 are electric motors separated in time by thirty years. They drive gears and sheaves manufactured in 1965 but modeled on equipment built eighty years previously. The juxtapositions between old and new are even more evident on the streets, where depression beams designed in 1980 are mounted in 100-year old yokes and conduit, and where cars rebuilt from the trucks up within the last five years carry roofs built in the 1890's.

Operating this antiquated technology, a technology characterized by high capital costs, inflexibility, and ponderously heavy construction, in a modern American city borders on the insane, yet the desire of San Franciscans to preserve this unique and - in its own fashion - workable transportation system dates back at least forty years. In light of the strength of this committment to the cable cars it is only fitting that this clumsy, inflexible, irrational system operate out of a powerhouse once considered one of the most complex in the industry.

URBAN DEVELOPMENT AND CABLE TRACTION

Historians, journalists, and real estate entrepreneurs have long claimed that the development of San Francisco's cable railway lines significantly boosted the city's growth. According to these writers new residential neighborhoods sprang up almost instantaneously along cable routes and the commercial sectors of downtown reaped benefits from the increased mobility which Andrew S. Hallidie's invention brought to the city's population. Historians have subjected many other communities in which cable railroads operated to intensive studies in an attempt to quantify the exact nature of the impact of the transportation system upon the city.[168] Surprisingly, no such study exists for San Francisco, the city where cable traction first operated successfully on a commercial basis. Nevertheless, the evidence supports the notion that the cable railways of San Francisco aided and hastened development in certain sectors of the city, notably the Mission District and the Western Addition, and in so doing helped transform the spatial organization and structure of the city.

Originally one goal of this study was a route by route, block by block examination of the impact of the cable car upon patterns of growth and development in San Francisco. However, the sources for such a rigorous analysis no longer exist. The earthquake and fire of April 1906 destroyed all records of property transactions, real estate assessments, and building permits, as well as most of the company records for the cable traction companies. Block books for San Francisco have not survived prior to 1895, and the city directories for this period contain little information pertinent to these questions. Census data suggest broad population flows within the city, but because of the manner in which the ward boundaries were drawn and the long periods between censuses it is difficult to trace these flows to such specific areas as the Mission or the Western Addition. Historical maps are similarly scarce and unyielding. The earliest surviving Sanborn Fire Insurance maps date from 1885, making it impossible to use these valuable sources to determine growth and development patterns in the crucial first initial years of cable car operations prior to 1885.

Despite these many obstacles, it was possible to locate several important sources of information. Many of these are highly impressionistic in nature; such as boosters' accounts in local newspapers, popular magazines, and trade journals. These sources concentrate on the business-related matters concerning the lines, relate humorous anecdotal material, or chronicle accidents involving cable cars. One journal, the San Francisco Real Estate Circular, provided a wealth of data about land values, housing starts, and the effects of the cable lines upon the city. It should be noted, however, that Thomas McGee, the editor of the Circular, served on the board of directors of the Ferries & Cliff House Railway, giving him a vested interest to show that the cable lines positively influenced the city's prosperity. Nevertheless the Circular proved to be a very valuable resource.

For the purposes of this report "urban development" has been limited to the concept of the physical expansion of the city. This involves the growth of street systems, residential housing districts, parks and other recreational

[168] See for example: Sam Bass Warner, Streetcar Suburbs (Cambridge: 1962). Robert Carson, A Micro Historical and Economic Study of the Rise and Decline of Street Railroads in Syracuse, New York, 1860-1941 (Washington: 1977). G.A. O'Geran, A History of the Detroit Street Railway (Detroit: 1931).

areas, the downtown core of the city, and the transport systems serving the community. Political, social, and economic trends in the city - although obviously important - are not the primary focus of this study.

The attempt to discover the impact of the cable car upon San Francisco generated a number of secondary questions. For example, if the cable railways affected the growth of the city, did they consistently foster a certain type of growth, such as residential, commercial, or recreational? The impact of San Francisco's environment upon the city's settlement and growth patterns also required consideration. It is possible that the city's benign climate and unwieldy topography influenced its patterns of development to a greater extent than the cable car.

The general and celebratory nature of most historical and contemporary accounts of San Francisco's cable railways reinforced the need for a careful study to determine the impact of the technology upon the community. Both historical and popular sources tend to credit the cable lines with vast developmental powers, while offering only the slightest shreds of supporting evidence. A newspaper article in the 1880's boasted that

> the construction of the cable lines was followed by a great real estate upheaval that brought sudden wealth to thousands of holders of what seemed the most unpromising property in the world. Andrew Hallidie made more millionaires than the Comstock, and opened up possibilities of development before undreamed of.[169]

Many writers argued that the cable railways changed the face of San Francisco and the lives of its citizens. Nineteenth century historian B.E. Lloyd proclaimed that the car lines

> leveled the sand dunes, reclaimed the marshes, filled up the gulches, and instead of a desolate and barren waste that was, there have sprung up blocks and streets of comely residences, the homes of thrifty and industrious citizens.[170]

A modern historian claims no less for the cable car, stating that

> more than any other technological development the street car was responsible for the spatial organization and structure of the. . . . city. Its routes determined the location of industry, the building and maintenance of commercial centers. . . . and the development of the suburb.[171]

These sources claim that the introduction of the cable lines, which carried greater numbers of people, longer distances at higher speeds than had the earlier horse-drawn street railways, altered residential patterns, industrial

[169] Andrew S. Hallidie Papers, Folder 8, California Historical Society, San Francisco.
[170] B.E. Lloyd, Lights and Shades in San Francisco (San Francisco: 1876), p. 175.
[171] Carson (1977), p. 1.

development, and even concepts of leisure and recreation.

Clearly, the literature is full of generalizations concerning the impact of the cable railways upon urban growth, but the evidence to substantiate these claims has not been collected, organized, or analyzed in a systematic way. From the standpoint of an economic approach to these questions there are additional obstacles to a clear picture. The effects of the national economic cycles, with their prevailing boom/bust pattern, was atypically intense in San Francisco. The city's business activity tended to be highly speculative and closely linked to the silver mines of Nevada's Comstock Lode. San Francisco's business cycles often mirrored the ups and downs of the silver mines.

Despite deficiences in quantity and reliability, the historical evidence found in newspapers, the Real Estate Circular, and a variety of other sources does support some of the assumptions made about the importance of the cable car to San Francisco's development. The evidence does not suggest that the cable car determined the city's urban patterns, but that it influenced these patterns is undeniable. The conclusions presented here must be considered tenative, for the reasons cited above. Nevertheless, it is clear that the cable railway system has exerted a profound effect upon San Francisco, an impact that transcends physical facilities and economic development to a position as a symbol of the city itself.

In 1776, while the American colonies deliberated over a brewing revolutionary war, Spanish officals in Mexico engaged in exploring and settling Alta California. That spring, Captain Juan Bautista de Anza led a party of missionaries and soldiers to the northern shore of San Francisco Bay. There the soldiers formed a garrison, or presidio. A few miles to the south Franciscan monks started the Mission of San Francisco de Assisi. Between 1780 and 1830 the population of the area remained fairly constant at about 500. As the hide and tallow trade of the area began to grow the Mexican government established a port of entry at the bay. In 1835 they founded the new town of Yerba Buena.

Shortly after the outbreak of the Mexican War in 1846, the United States conquered the province of California and renamed Yerba Buena San Francisco. In 1848 the United States took formal possession of the town under the terms of the Treaty of Guadalupe Hidalgo. Within a year of their arrival the Anglos began laying plans for the development of the town. Jasper O'Farrell surveyed the city in 1847, extending the rigid grid pattern first established by the Mexican settlers into the largely unpopulated lands west of the settlement. O'Farrell also laid out Market Street, a diagonal artery running southwest from the settlement. Market quickly became the principal thoroughfare of the town, and remains so to this day. Subsequent development in San Francisco, particularly in downtown, south of Market, the Western Addition and Mission Districts, corresponded closely to O'Farrell's survey.

San Francisco's population skyrocketed following the discovery of gold in the Sierra foothills in 1848. In 25 years the city grew from a small settlement of 1000 into a major city of over 150,000.[172] These early residents of the city grappled with a climate and topography that played a major role in determining the patterns of growth within the city. San Francisco's location at the tip of a peninsula, surrounded on three sides by water, severely restricted the amount of space available for expansion. Most of the early residents settled on the eastern, or lee side, of the peninsula. There hills now known as Russian, Nob and Telegraph Hills, and Pacific Heights, offered shelter from the cold, foggy winds coming off the Pacific and held at bay the sand dunes that dominated the western half of the peninsula. These factors restricted the earliest settlement to the eastern portion of the peninsula along both sides of Market Street, and extending south towards the Mission.

From the 1850's to the 1880's San Franciscans leveled some of the smaller sand dunes and hills in the vicinity of Market Street and used the surplus land for fill, with which they extended the city well into the bay. The larger hills to the west and the dunes beyond remained largely inaccessible and uninhabited, pinning the population of the city against the eastern shore of the bay.

The Gold Rush brought an incredible increase in San Francisco's population. The growing size of the city resulted in an increasing demand for public transportation. A steam dummy line operated along Market Street as early as 1860. In the following year the first horsecar line in the city opened. The next two decades witnessed a rapid extension of these lines throughout San Francisco. An 1865 city directory praised the horsecar lines and noted their importance to the community, noting, "It is hardly too much to say that the modern horse car is among the most indispensable conditions of modern metropolitan growth. . . . The horse car virtually fixes the ultimate limits of suburban growth."[173]

Despite their benefits, horsecars had many shortcomings. They were considered little faster than walking, uncomfortable, and a major source of unsanitary conditions in the city. Horses wore out and needed to be replaced frequently. They often carried disease. These problems, coupled with an increasing push to populate and develop the steep hills overlooking the city, where horsecars could not operate efficiently, provided ample incentive to search for an alternative mode of mass transit.

Andrew S. Hallidie and his three financial partners, James Moffitt, Joseph Britton, and Henry Davis, organized San Francisco's first cable traction company, the Clay Street Hill Railroad, in May 1873. About a quarter of the $110,000 cost of constructing the line was furnished by property owners along Clay Street. Although their $28,000 contribution signified a certain degree of confidence and faith in the experiment, it should be noted that the original pledge to the company amounted to $40,000, but very few individuals could be persuaded to subscribe for the stock of Hallidie's firm.

The Clay Street Hill Railroad opened for revenue service on 1 September

[173]Bion Arnold, Report on Transportation Facilities, City of San Francisco (San Francisco: 1912), p. 415.

1873. It quickly proved a financial success, and by 1876 was transporting 150,000 people annually. Historian George W. Hilton states that "as Hallidie and his associates had hoped, the installation developed Nob Hill very well. . . .[174] In October 1873 the San Francisco Real Estate Circular gave its opinion of the anticipated effects of this new transportation system on the city

> It has for years been a saying here that our high hills are the most healthy, commanding and pleasant places for residence, but few had either the strength or taste for climbing them. Everybody liked them when there, but to climb them was the difficulty. Should the Clay Street Hill Railroad prove a success, it will make property on the hills over which it runs as accessible as land on level ground south of Market Street. Real estate and rents on the hills will thereby have a great impetus.[175]

By November the Real Estate Circular had begun to write eye-catching headlines about "High Prices on the Hills." An advertisement for a $15,000 fifty-vara lot on Clay and Gough Streets is a typical example of this phenomenon.[176] Hallidie himself purchased a lot on Nob Hill prior to the construction of the Clay Street Hill Railroad for $3000, selling it eighteen months later, after completion of the line, for $9000.[177]

The Real Estate Circular was so confident of the future of cable traction that in May 1874 it announced "beyond a doubt, this method of traction will be used on all the street-railroads of this and every other city of the United States within a few years."[178] Despite this acclaim, two and a half years elapsed before the Sutter Street Railroad converted from horsecars to cable operations, giving San Francisco its second cable railway.

The fact that the Sutter Street line operated over only moderate grades and climbed no steep hills, unlike the Clay Street Hill Railroad, marked a significant development in cable traction, and proved the adaptability of the cable car to operations over flat terrain. The Sutter Street Railroad marked the first real thrust of a cable railway into the largely undeveloped Western Addition section of the city.

Both the Clay and Sutter Street lines replaced earlier horsecar operations, initiating the general demise of the horsecar in San Francisco. Operating expenses for the Sutter Street Railroad's cable cars proved to be 30% lower than for the horsecars they replaced. At the same time the cable cars carried

[174]Hilton, p. 185.
[175]San Francisco Real Estate Circular, 7 (October 1873).
[176]A fifty-vara lot is one-sixth the size of a standard block, measuring aproximately 137.5 feet square. California Architecture and Building Review (1 January 1880).
San Francisco Real Estate Circular, 7 (November 1873).
[177]Street Railway Journal, 1 (April 1885), p. 116.
[178]San Francisco Real Estate Circular, 8 (May 1874).

over 900,000 more passengers than the horsecar lines during their first year of operation. Publication of this information must have produced a tremendous effect upon the owners of most of the city's transportation companies. Surely it encouraged the Sutter Street firm to expand its operations and construct, in 1878, the first crosstown (north-south) line in the city.

The first real impetus for a citywide movement of population toward the Western Addition came with the opening of the California Street Cable Railroad in April 1878. Henry Root, working under the close supervision of principal owner Leland Stanford, pushed the California Street line into the Western Addition and extended the route .8-miles farther west with the extension of the line to Central (now Presidio) Avenue in 1879.

In addition to providing access to the Western Addition, the California Street Cable Railroad also furnished a second route up Nob Hill. In the same year that he obtained a franchise for the cable line Stanford broke ground for his mansion atop the Hill. Historian John Young stated in 1912 that the effect of Stanford's choosing Nob Hill for the site of his mansion proved "very marked. . . . It at once decided that the movement of the fashionable world would be westward."[179] The San Francisco <u>Chronicle</u> recalled in 1909 that "the commencement of the road gave an impetus to the value of property on the Hill at once and during the progress of the work, real estate values were enhanced from 40 to 100 percent along the car line."[180] It is impossible to fix these values exactly, but the general tenor of the report seems to confirm the fact that a good deal of development occurred atop Nob Hill during and after the construction of the car line. Stanford's home proved only the first of a succession of palatial estates constructed atop Nob Hill. Some historians claim that Stanford built the California Street Cable Railroad simply for the convenience of the wealthy residents of Nob Hill, while others believe the development of the Hill as an fashionable residential neighborhood resulted from the convenient transportation furnished by the cable line. The exact nature of the relationship between the California Street Cable Railroad and the settlement of Nob Hill is uncertain, but the diversified ridership of the line, which ran through the heart of Chinatown, indicates that patronage of the cars was not limited to the wealthy.

The <u>Real Estate Circular</u> prophecied the importance of the cable car to hilltop living in the issue in which it announced the granting of Stanford's franchise. The writer remarked that

> The wire-cable mode of propelling street cars being susceptible of use on the very steepest hills, where horses could not possibly be used, will prove ultimately to be one of the most valuable aids to increasing San Francisco real estate values ever devised. The hills would be inaccessible but for the wire-cable railroads. . . It will therefore, in future, be possible to have a residence on the steepest side-

[179] John Young, <u>San Francisco, A History of the Pacific Coast Metropolis</u>, 2 vols. (San Francisco: 1922), 2:passim.
[180] San Francisco <u>Chronicle</u> (1909).

> hills, and still be in a place that will be quickly, easily, and cheaply accessible.[181]

John Young also linked the development of Nob Hill with that of the Western Addition, noting that "the stamp of fashionable approval and improved transportation facilities would cause the filling up of the Western Addition."[182] The Real Estate Circular extolled the anticipated benefits of the new line, stating

> This road will open up easy, direct, and cheap communication with the northern and neglected portion of the Western Addition and with Golden Gate Park. It will fill a want which has long been felt. We have already a finer park than most cities can boast of. . . . but, for want of a cheap and rapid transportation, it has been beyond the reach of the class who would most frequently seek it in search of health and recreation. . . . A most populous neighborhood will be opened up rapidly, in a district well suited for residences, but hitherto cut off from communication with the city.[183]

Thomas McGee, editor of the Real Estate Circular, chafed at the delays in the construction of the California Street line, but when construction finally began on 5 July 1877 he again praised the line and the benefits it would bring to the city.

> The line will be of great service to that section of the city lying between Clay and Bush Street. It never has had any but snail like car communication. Fast time will be made on the new line, which will be most substantially built.[184]

If McGee represented the views of the San Francisco real estate community as a whole, the California Street Cable Railroad was widely seen as an opportunity to both raise property values and encourage development of new geographic areas.

Although they benefited the wealthy living on the hill tops, the cable roads did not operate exclusively for the Stanfords and other nabobs. Frequent references attest to their use by the working classes as well. McGee trumpeted the fact that the California Street line would "be an early and late one. . . . it will run early enough to accomodate the working classes, and late enough to accommodate theatre-goers."[185] He supported the ridership of the working class, complaining that the "Clay Street Hill Railroad cars do not leave the northern read western terminus to bring passengers down into the city each morning until 20 minutes to 8 o'clock. . . . Working people can not use it in the mornings at all."[186] McGee also demanded that the cable companies supply additional seats for "tired workingmen, clerks and working

181 Ibid.
182 Young, passim.
183 San Francisco Real Estate Circular, 10 (May 1876).
184 San Francisco Real Estate Circular, 12 (July 1877).
185 San Francisco Real Estate Circular, 12 (May 1877).
186 San Francisco Real Estate Circular, 12 (April 1877).

girls" returning from their jobs.[187]

The desire to provide transportation to the parks in the western portion of the city becomes evident in contemporary accounts beginning in about 1878. The city established Golden Gate Park in 1870, but the area remained largely sand dunes for nearly a decade. Once improvements were made Golden Gate Park became a popular recreational spot. Buena Vista Park is listed on maps of this period as simply "Park," apparently serving recreational needs from as early as 1873.

The Real Estate Circular raised the cry for cable car service to these recreational areas in November 1878, but it was five years before any cable line reached Golden Gate Park.

> If a wire cable road were built from Market Street to the Park, on either Hayes, Fell, Oak, Page or Haight, he wrote the effect would be immediately to advance land around Buena-Vista Park and the Great Park Golden Gate . Even already, the improvements made, and the prospects of a cable railroad, have advanced the prices of land there.[188]

A month later the Circular again took up the cry,

> Three or four years ago we stated that the next real estate excitement westward would be for land out by the parks, for the erection of fine houses. The projectors of a new wire cable railroad will in ten years have one of the most valuable street railroad franchises in the country.[189]

These two statements are interesting for several reasons. They highlight the fact that the interest of the Circular in recreational opportunities for San Francisco's citizens was matched by a desire to advance property values. They also illustrate the difficulty of attempting to determine whether cable lines opened new areas such as those around the parks to development, or whether the settlement of these districts encouraged cable companies to build new lines to meet the transportation needs of the new residents. From the tone of these statements it would appear that the cable lines that ran to the park districts in the Western Addition provided transport services to a district already developing. While the cable lines undoubtedly made these districts appear more attractive to people considering taking up residence near the parks by providing convenient service to the center of the city, they do not appear to have been solely responsible for this movement.

Three cable companies provided service to Golden Gate Park. The Geary Street Park & Ocean Railroad came within several blocks of the park in 1880, and extended its service to its border in 1892. The Market Street Cable Railway ran lines down McAllister, Haight, and Hayes Streets to the Park in 1883 and 1886, the Hayes and Haight Street lines ran along streets earlier suggested by the Real Estate Circular. In 1889 the Omnibus Railroad & Cable Co. built a

[187] San Francisco Real Estate Circular, 14 (March 1879).
[188] San Francisco Real Estate Circular, 14 (November 1878).
[189] San Francisco Real Estate Circular, 14 (December 1878).

line to the eastern edge of the Park along Oak Street, another of the routes suggested by the Real Estate Circular.

McGee called the opening of the Geary Street line in 1880 "one of the most important city events of the month."

> The company finds that on a fine Sunday it may. . . . carry from 25,000 to 30,000 passengers. The Park has hitherto been unvisited and almost unknown, except to a small class who can indulge in buggy and horseback riding. It is now within reach of all, and the thousands who have visited it since the Geary-street line was opened, show how much. . . . better access to it was needed.[190]

Observers felt that the two Market Street Cable lines that opened in 1883 would spur development in the area and provide better access to the Park than that provided by the Geary Street Park & Ocean. A year prior to its opening the Real Estate Circular predicted that "construction of the Haight Street railroad will make a great change in the value of land in the neighborhood of the Park terminus of this line. The streets adjoining will be among the most fashionable and the most healthy of any in the city."[191]

Property values along the line did increase, according to the Street Railway Journal, which reported that an unimproved block on Fillmore near Haight that had sold for $20,000 in 1881 increased in value to $50,000 by 1886. The Journal also reported that Market Street Cable purchased a block on Haight for $20,000. Before construction of the cable line the same block sold for $12,000. In 1886 Market Street Cable resold half of the lot for $30,000, retaining the other half.[192] Although evidence is too sketchy to prove the existence of this pattern throughout the city, it is clear from this account that at least one cable traction company invested in the property along its routes, apparently for resale on speculative grounds.

The Haight benefited greatly from both its proximity to the Park and the new cable lines. Haight and Stanyan Streets served as the center of the transportation network stretching from the center of the city to Golden Gate Park. The Haight Street line and the Geary Street Park & Ocean operated car barns in the area and the turntables for the Haight and Oak Street lines were located near the intersection. A report published by the City of San Francisco noted that the "simultaneous development of the park and the streetcar system stimulated building, increased property values, and made the Haight a center of social activity for the entire city." The report cited an increase in property values along the eastern edge of the park from $25-50 per front foot in the early 1880's to $125-250 in 1891.[193]

Real estate values advanced rapidly in the Haight throughout the 1880's as the

[190] San Francisco Real Estate Circular, 15 (March 1880).
[191] San Francisco Real Estate Circular, 17 (October 1882).
[192] Street Railway Journal, 53 (April 1886).
[193] Arnold (1912), pp. 2-3.

area developed into a middle income and working class neighborhood. A year after the completion of Market Street Cable's first lines into the area the Real Estate Circular reported that

> the Western Addition was the banner portion of the city last year. . . . Very much the most of this increase of sales occurred along or near the McAllister and Haight street lines of cars, particularly the later. Fifty-vara after fifty-vara, block after block, out there has been sold, generally in subdivisions, and never at high prices.[194]

Although prices remained low enough to attract middle income families to the area, it is clear that land values rose significantly after the completion of the new lines. In August 1884 the block bordered by Oak, Fell, Fillmore, and Steiner Streets sold for $35,000. In May of 1881, before the appearance of the cable lines in the area, the same block brought only $25,000. Similarly, the block bounded by Page, Oak, Pierce, and Scott sold for $32,000 in 1884, after selling for $23,900 in June 1880 and $25,000 in August 1882.[195]

The years 1884 and 1885 saw "something of a rush on the part of small buyers for cheap vacant suburban building lots" in the Western Addition because of both the completion of the cable routes and a drop in interest rates. These two factors enabled buyers to purchase inexpensive lots previously considered inaccessible to people working in the heart of the city. Although the prices for lots in the Western Addition appreciated significantly in value during these years they still remained within the reach of many middle class and working class buyers who could not afford the price of lots in the center of the city. By the end of 1885, however, "the rush for cheap lots exhausted itself."[196]

The great number of houses erected on these newly purchased lots is another measure of the rapid development of the Western Addition during these years. In 1887 one-third of the 1350 land sales in the area underwent further development. Many of these new owner-occupants came from the working class, moving into the district from the area south of Market Street. The Real Estate Circular reported that these mechanics and clerks willingly endured a commute five to ten minutes longer in order to take advantage of the relatively lower real estate prices in the Haight and other Western Addition districts.[197]

> The cable car runs so fast that six or eight blocks in distance makes very little difference in time, while they make a very great difference in price and so the cheapest lots rather than the nearest are now purchased most frequently.[198]

The boundaries of census tracts shifted frequently during this period, making

[194] San Francisco Real Estate Circular, 20 (December 1884).
[195] San Francisco Real Estate Circular, 19 (August 1884).
[196] San Francisco Real Estate Circular, 22 (December 1886).
[197] San Francisco Real Estate Circular, 21 (December 1885).
[198] San Francisco Real Estate Circular, 21 (March 1886).

it virtually impossible to quantify the exact extent of population movement within the city, but the addition of new census tracts in the Western Addition suggests a heavy flow into this area.[199] In addition to increased settlement, the area also developed support facilities for the growth of the area as the city's primary recreational district.

> It was not at all unusual to see thousands of people swarming to the park on weekends. An amusement center was operating at Haight and Cole. Bars, bike shops, hotels, restaurants, a livery stable, and numerous other services sprang up along Stanyan.[200]

McGee's Real Estate Circular also promoted other areas in the Western Addition, calling for a direct cable line to the Presidio in 1878.

> Land toward the Presidio is practically as inaccessible as though it were at San Mateo about 20 miles south of San Francisco . . . . Such a road will alone bring real estate up to its true value there. That end of the city, heretofore almost utterly neglected, is, in fine weather, one of the most desirable portions of the peninsula.[201]

McGee noted the fact that the owners of the Presidio & Ferries Railroad, which built a route to the Presidio in 1880, included "men of means and large property owners in the direction in which the line is to run. This. . . . is the reason that impels them to build the road."[202]

In 1891, the San Francisco Journal of Commerce commented that with the cable car "it became possible to travel two to three miles from the center of the city in 20 minutes to half an hour, and new streets were opened, while new blocks of buildings sprang up as if by magic."[203] Certainly this description is accurate for the Western Addition where, in 1881, growth occurred at a rate approximately three times as rapid as in the other sections of the city.[204]

The Mission District, located to the south of the center of the city, did not enjoy anything so dramatic as this rate of growth, something the Real Estate Circular lamented.

> The Western Addition is now pretty well supplied by four cable lines in operation. . . . The Mission in this respect is subject to a disadvantage, from which it did not suffer before these new lines were introduced westward. The Mission will not have a fair chance in the competition with other districts in the city until one or two cable lines are running

[199] U.S. Census Bureau, Report on the Social Statistics of Cities, Part 2, San Francisco, California, 1887.
[200] Department of City Planning, Report, p. 3.
[201] San Francisco Real Estate Circular, 14 (September 1878).
[202] Ibid.
[203] San Francisco Journal of Commerce, Builders of a Great City: San Francisco's Representative Men, the City, its History and Commerce, p. 56.
[204] San Francisco Real Estate Circular, 17 (December 1881).

to it.[204]

In 1883 the construction of the Market and Valencia Street lines of the Market Street Cable Railway partially corrected this inequity. In anticipation of their opening the Real Estate Circular prophesied "a decided change for the better in Mission property."[205] Nine months later, having learned that construction of the lines would definitely take place, McGee urged that readers contemplating "buying or building along Valencia Street. . . . may now with confidence go ahead with their building or purchases."[206]

The growth of the Mission proved less regular and predictable than that in the Western Addition. Certain streets, such as Valencia, tended to realize a great deal of growth, while others, also served by cable lines, remained stagnant. Despite these variations McGee persistently urged the conversion of horsecar lines to cable operations, "a change that would have a most beneficial effect on Mission property."[207]

Certain blocks along Valencia tended to exhibit a greater increase than the rest of the street. In 1885 McGee noted that "no Mission property has advanced in price within a year, except that on Valencia and Mission, say, between, 16th and 22nd."[208] The following year he reported a 20-30% increase in property values along Valencia from Market to 26th Street, the limit of the cable line. A lot on the northwest corner of Valencia and 13th Street sold for $4500 in March 1885, and was resold in November 1886 for $6100.[209]

Even in these cases it is difficult to conclude that the cable lines directly affected real estate values. The Real Estate Circular posited a possible influence of the cable cars upon the Market Street shopping district in 1886, noting

> the four lines of the Market Street Cable Company operating on Market Street run so fast and frequently that they form a nearly continuous line of cars. . . . They are of great value to stores, by means of their dummies. Passengers riding on the dummies have a merchants name and business impressed on their minds through their eyes as they never had on the old closed-in horse cars.[210]

It is interesting to speculate about the possible influence merchants along Market Street might possibly have exerted upon Henry Root's design for the combination cars adopted by the line. The forward portion of these cars retained the open arrangement of the early dummies, which McGee felt increased the lure of the street's stores upon the riders.

204 San Francisco Real Estate Circular, 15 (April 1880).
205 San Francisco Real Estate Circular, 15 (September 1880).
206 San Francisco Real Estate Circular, 16 (May 1881).
207 San Francisco Real Estate Circular, 20 (December 1884).
208 San Francisco Real Estate Circular, 21 (December 1885).
209 San Francisco Real Estate Circular, 22 (December 1886).
210 San Francisco Real Estate Circular, 21 (December 1886).

The Real Estate Circular's editorial stance may also have altered perceptions concerning the relationship between the cable lines and property values. By 1884 the paper's advertising columns carried a listing for "Lots Along the Cable Lines," and its news pages seldom hesitated to proclaim the virtues a cable line held for the districts it served.[211]

Throughout the 1880's and 1890's the Real Estate Circular argued that the improvement of San Francisco's transportation system through the construction of cable lines would diminish out-migration, across the bay to Oakland. In 1880 McGee wrote that

> time, cheapness of access and the low price of lots are the points that create real estate progress. It will soon be utterly impossible for suburban lots to compete with the vacant lots of this city. . . . Oakland must therefore take a back seat.[212]

Ten years later McGee credited the cable car with saving San Francisco from being depleted by the lures of Oakland.

> But for our cable lines, which run everywhere, Oakland therefore would have a population of at least 50,000 more than they have now. Had five of our main cable lines been built fifteen years earlier, Oakland. . . . would have 25,000 less people than they have now. From 1873 to 1880 people left this city by the thousands every year because of the slowness of the horse car lines and of the difficulty of getting a seat on them. . . .[213]

Even in 1893 it took little imagination to realize that San Francisco's cable railway system had peaked. At that time nine lines extended deep into the Western Addition, three had made inroads into the Mission, and an additional three ran crosstown. The cars ran over more than 50 miles of double-tracked streets, an increase in mileage of over 50% in five years. Still the decade of the 1890's proved hard times for both San Francisco and the cable car. Real estate values and sales dropped by nearly 50% between 1891 and 1893, as the city experienced a severe economic downswing. During these same years the electric streetcar became a practical transportation system for urban streets. With its last major shortcomings removed, the electric streetcars began supplanting the cable lines in earnest.

The depression of the 1890's struck particularly hard in the outlying areas of the city, such as the Richmond District and the Point Lobos Avenue vicinity.[214] Even the Haight and Mission Districts, which previously had enjoyed rapidly rising property values, now experienced serious setbacks in terms of property values and prices. McGee reported that "There was not a lively demand for any kind of Mission property in 1892. Even Mission and

[211] San Francisco Real Estate Circular, 19 (April 1884).
[212] San Francisco Real Estate Circular, 15 (September 1880).
[213] San Francisco Real Estate Circular, 25 (May 1890).
[214] San Francisco Real Estate Circular, 28 (December 1892).

Valencia Streets, both destined to be good business streets, were not much sought after by buyers."[215]

The depression notwithstanding, Market Street Cable's Castro Street line prospered during the early 1890's. In 1892 McGee claimed that "the business of no line of the Market Street Cable systems has grown so much as that of the Castro Street line within two years," and that "the chief inquiry for Mission property was along and contiguous to the Castro Street line, where the prices are within the reach of small buyers."[216] In the following year the Real Estate Circular reported that "the number and value of the sales at the Mission. . . . were proportionally larger than in any other suburb of the city, but prices were as weak there as elsewhere."[217]

To a certain extent those areas which enjoyed the greatest increases in values prior to the depression suffered the greatest losses. McGee commented that, "it is especially characteristic of a boom market to send prospective business property up in the air, and of a dead real estate market to let it drop as much too low as it was previously too high."[218] The experience of the Haight, where the greatest gains occurred prior to the 1890's, tended to confirm this notion. In 1892 the Real Estate Circular claimed that "as a rule all lots westward from Fillmore to Stanyan, and from. . . . Fulton to Waller, brought 10 to 25 per cent less than they sold for in 1890 and. . . . 1891. This was due to oversupply and inflated prices."[219] Real estate values in the Western Addition fell off another 20% by 1893, and

> that portion. . . . in which credit sales and booming most prevailed -- say between Divisadero, Stanyan, McAllister, and Waller -- has suffered most. Lots on Page, Oak, Fell and other streets facing or contiguous to the Panhandle of the Park, which sold two to four years ago at $2,800 to $3,200 each, are now quotable at $2,350 to $2,500 each.[220]

Despite such declines the future appeared bright for both the Mission and the Western Addition. The Real Estate Circular noted that the Haight "is on the line of city growth westward, and it is well-supplied with cable car lines, its improvement cannot long be retarded," an evaluation which might also have been applied to the other districts of the city served by the cable car.[221]

By the time San Francisco's economic health improved in 1894 the cable car's domination of the city's urban transportation system was threatened by the electric trolley, which had been first used successfully in the area in 1891. Once loyal to the cable cars, the Real Estate Circular quickly threw its allegiance behind the newer technological innovation, noting that

[215] Ibid.
[216] Ibid.
[217] San Francisco Real Estate Circular, 29 (December 1893).
[218] San Francisco Real Estate Circular, 30 (December 1894).
[219] San Francisco Real Estate Circular, 28 (December 1892).
[220] San Francisco Real Estate Circular, 29 (December 1893).
[221] San Francisco Real Estate Circular, 28 (December 1892).

> it is obvious that we are on the eve of having an efficient and practical electric locomotive engine. It will be particularly well adapted for street cars; it will be less costly than propulsion by cable and fixed engines, and will in all probability revolutionize street travel.[222]

The cable car's heyday was history. During the 1890's the number of articles dealing with cable traction in trade journals, popular magazines, and newspapers steadily diminished, while those on electric streetcars increased. In a sense, the cable car had already given way to the trolley during the depression of the early 1890's, but the event escaped notice until after the onset of economic recovery. The extensive growth experienced by San Francisco during the mid-1890's can not be attributed to the cable car, despite the fact that the lines were more extensive than ever before. The newly developing areas of the city relied upon the growing number of electric trolley lines for transportation. The first substitution of electric trolleys for cable operations dates from this period, and such substitutions occurred with ever increasing rapidity during the 1890s. This trend continued until the earthquake and fire of April 1906. After that catastrophe the resulting devastation provided the impetus needed for the widespread replacement of the cable lines. This process gained further encouragement from the bribes United Railroads of San Francisco tendered to the City and County Board of Supervisors.

By the late 1880's the relationship between cable traction and urban growth had become tenuous, expansion and growth in the outlying Mission and Western Addition districts depended upon a more complex set of circumstances than merely good transportation services. During the 1870s and 1880s the connection between the cable lines and the development of these areas is fairly demonstrable. The combination of the depression of the early 1890s, the adoption of the electric streetcar, and the earthquake and fire of April 1906 all combined to shift the emphasis of the city's transportation systems away from the cable car toward the electric trolley. Although the cable car survived in San Francisco, its era had passed.

[222] San Francisco <u>Real Estate Circular</u>, 19 (October 1894).

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APPENDIX

San Francisco Cable Railway
Guide to Appendix

The xeroxed photographs which appear in this Appendix are copied from various archives listed below. These archives would not allow copy negatives of these photographs to be made for the HAER collection. Because of the useful information contained within the photographs, we are providing researchers using the collection with access to these photocopies. However, should researchers wish to obtain copies of these photographs, they must consult the appropriate archives directly. A 4x5 inch print of each of these photographs may also be found in the HAER field records for the San Francisco Cable Railway Project.

Credit BL: Photocopies of historic photographs and engravings from the collections of the Bancroft Library, University of California, Berkeley. Contact Bancroft Library concerning usage restrictions.

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Credit RDG: Photocopies of historic photographs from the Roy D. Graves Collection, Bancroft Library, University of California, Berkeley. Contact Bancroft Library concerning usage restrictions.

Photo #1 — Credit BL.
CAR TERMINI AT OLD FERRY BUILDING: Photocopy of photograph, c.1890 of the Ferry Building at the foot of Market Street. View to northeast. The Ferry Building served as terminus for many cable car lines, including the Howard Street branch of the Omnibus Railroad & Cable Co., one of whose cars is evident in the foreground.

Photo #2 — Credit CS.
TRANSPORTING CABLE: Photocopy of 1883 photograph showing hauling of first cable to Market Street Cable Railway's McAllister Street powerhouse. Smokestack of powerhouse is visible behind car barn in foreground. Note massive construction of wagon, and large number of horses required to haul cable.

Photo #3 — Credit RDG.
REBUILDING GEARY & LARKIN CROSSING: Photocopy of October 1906 photograph showing rebuilding of crossing of the Geary Street Park & Ocean Railroad and the Sutter Street Railroad (United Railroads of San Francisco) at Geary and Larkin. Note the complicated arrangement of yokes, slot rails, and track rails.

Photo #4 Credit MUNI.
CALIFORNIA & MASON SHEAVE PIT: Photocopy of September 1957 photograph of California and Mason Street sheave pit. View is to the west. This double-sheave directs the cable into and out of the blind conduit on Mason that connects the powerhouse with the California Street line.

Photo #5 Credit SFPL.
RECONSTRUCTION ON HYDE STREET: Photocopy of photograph showing rebuilding of the Hyde Street line in 1956-57. View looking north on Hyde to Beach Street. The yokes for the left-hand trackway are embedded in their concrete conduit, while those for the right-hand track are still exposed.

Photo #6 Credit RDG.
PULL CURVE CONSTRUCTION: Photocopy of an 1883 photograph showing construction of a pull curve at Market and Haight Streets for the Market Street Cable Railway. Plainly evident in the foreground are the flared, horizontal pulleys which guided the cable through the curve. The flare prevented the cable from sliding off the bottoms of the pulleys.

Photo #7 Credit RDG.
PARTIALLY COMPLETED TURNTABLE:- Photocopy of a c.1885 photograph showing workers posed on a partially completed turntable. The two sets of tracks on the table indicate that it might have belonged to the Market Street Cable Railway. The location is unknown.

Photo #8 Credit RDG.
SOUTH SIDE AND EAST FRONT OF F&CH RWY POWERHOUSE: Photocopy of c.1893 photograph showing the Ferries & Cliff House Railway's powerhouse and car barn at Washington and Mason. View of south side and east front. Compare appearance of this building with that of the structure erected following the 1906 earthquake and fire.

Photo #9 Credit RDG.
EAST FRONT OF F&CH RWY POWERHOUSE: Photocopy of c.1904 photograph showing east front of the powerhouse and car barn. Note the annex at the far right of the photograph and the decorative canopy at the building's southeast corner.

Photo#10 Credit RDG.
WASHINGTON & MASON POWERHOUSE AFTER EARTHQUAKE: Photocopy of photograph taken on the morning of 18 April 1906 showing powerhouse and car barn. View is looking east down Washington Street towards the building's southwest corner. The people standing in the street in the background are watching the fire as moved up the hill from downtown. Note the relatively undamaged state of the building, as compared to CA-12-37 and CA-12-38, which show it following the fire. Also note the car trapped by falling bricks as it exited the building.

Photo #11 Credit RDG.
WASHINGTON & MASON POWERHOUSE AFTER FIRE: Photocopy of photograph taken in April 1906 showing southwest corner of powerhouse and car barn. Approximately the same view as CA-12-36, but taken after the fire ravaged the area. Photographs CA-12-36 and CA-12-37 were taken by a United Railroads of San Francisco phographer for insurance purposes.

Photo #12 Credit RDG.
SOUTHEAST CORNER OF POWERHOUSE AFTER FIRE: Photocopy of an April 1906 photograph showing the southeast corner of the powerhouse and car barn after the earthquake and fire. The extent of the damage suffered by the building is plainly evident. A portion of the steam engines that drove the winding machinery is visible through the two corner windows.

Photo #13 Credit RDG.
SOUTHEAST CORNER OF POWERHOUSE DURING RECONSTRUCTION: Photocopy of March 1907 photograph taken during reconstruction of the powerhouse and car barn. View looking north on Mason Street towards southeast corner of building. The cars standing in Mason Street were stored on the street until completion of the new building. Steam rising from building's interior indicates that at least one of the lines operated out of the building had resumed service. Note scaffolding around the walls.

Photo #14 Credit RDG.
WASHINGTON & MASON STREETS DURING RECONSTRUCTION: Photocopy of 1907 photograph, not 1906 as noted on print, taken during reconstruction of the powerhouse and car barn. View looking north on Mason towards the intersection of mason and Washington. Cable cars stored in the street in front of the building are clearly evident. The south wall of the building is visible behind the two cars on Washington Street.

Photo #15 Credit CHS.
HALLIDIE GRIP PULLEY: Photocopy of 1879 engraving of the Hallidie grip pulley. Invented by Andrew S. Hallidie this device drove the cables of the Clay Street Hill Railroad and the Presidio & Ferries Railroad. The jaws on the outer rim of the pulley alternately grasped and released the cable, supplying the adhesion required to prevent the cable from slipping. Engraving from Hallidie's The Mechanical Miner's Guide 3rd ed. (1879).

Photo #16 Credit CHS.
F&CH RWY STEAM ENGINES - 1888: Photocopy of 1888 Risdon Iron Works builder's photographs of the steam engines installed by the firm in the Ferries & Cliff House powerhouse. View is from southeast corner of the building looking out towards the winding sheaves and tension

runs. The engines are brand new, and have not even had the cables strung over the winding sheaves yet. The brick wall in the left background of the photograph separated the original boiler room from the rest of the building. Note the winding sheaves, engine flywheel, and gearing in the background of the photograph.

Photo #17 Credit CHS.
STEAM ENGINES - F&CH RWY POWERHOUSE: Photocopy of 1888 Risdon Iron Works builder's photograph showing the steam engines installed by the firm in the Ferries & Cliff House powerhouse. View towards east wall of the building.

Photo #18 Credit CHS.
WINDING SHEAVES - 1888: Photocopy of 1888 Risdon Iron Works builder's photograph of the winding sheaves installed by the firm in the Ferries & Cliff House powerhouse. The cables have not yet been wrapped over the sheaves. View from the south towards the northeast corner of the building. Note the low height of the ceiling compared with the present building.

Photo #19 Credit NMM.
F&CH RWY POWERHOUSE ELEPHANT BOILERS: Photocopy of 1893 Union Iron Works builder's photograph of the 56"x16' elephant boilers fabricated by the firm for the Ferries & Cliff House Railway. The boilers were installed along the west wall of the first floor of the powerhouse in 1894.

Photo #20 Credit NMM.
ELEPHANT BOILERS FOR F&CH RWY POWERHOUSE - 1894: Photocopy of May 1894 Union Iron Works builder's photograph of the 56"x16' elephant boilers fabricated by the firm for the Ferries & Cliff House Railway.

Photo #21 Credit CHS.
ENGRAVING OF ELEPHANT BOILER: Photocopy of 1896 engraving of an elephant boiler used by the Sutter Street Railway in their Polk and Sutter Streets powerhouse. Engraving from the Union Iron Works Catalogue No. 1 (1896).

Photo #22 Credit RDG.
FIRST FLOOR INTERIOR - 1905: Photocopy of April 1905 photograph showing the interior of the Washington and Mason Streets powerhouse. View towards southeast corner of the first floor of the building. The winding sheaves are in motion under the vertical steam engine in the foreground. The horizontal steam engines are visible in the background of the photograph. Note the cable support pedastal and cable just left of the column on the far right of the photograph.

Photo #23 Credit RDG.
FIRST FLOOR INTERIOR - AFTER FIRE: Photocopy of April 1906 photograph looking into the southeast corner of the powerhouse following the earthquake and fire. View from the north. The damage suffered by the steam engines and winding machinery is clearly evident. Compare this view with the pre-earthquake interior in CA-12-58.

Photo #24 Credit CS.
ENGINES AND WINDING MACHINERY - AFTER FIRE: Photocopy of May 1906 photograph looking through the easternmost window on the Washington Street (south) side of the powerhouse at the wreckage of the steam engines and winding machinery. Note the flywheel of the horizontal steam engine, bull gears, and winding sheaves buried beneath the rubble.

Photo #25 Credit CS.
INSTALLATION OF 1911 ELECTRIC MOTOR: Photocopy of June 1911 photograph taken during installation of the 600hp General Electric motor in the Washington and Mason Streets powerhouse. View towards southeast corner of first floor of building. The motor's chain drive lies on the floor in the center foreground. Winding sheaves and part of one of the tension runs are visible on the far left of the photograph.

Photo #26 Credit MUNI.
INTERIOR VIEW TO WEST ON FIRST FLOOR - 1956: Photocopy of November 1956 photograph of first floor interior of the powerhouse. View towards west wall. The old boiler pits, covered by a concrete slab in 1958, are visible in the foreground. The smokestack is evident on the far left of the photograph. Note the boiler located along the west wall of the building in the center background.

Photo #27 Credit MUNI.
FOUNDATIONS FOR MOTOR & REDUCTION GEAR NO. 1: Photocopy of November 1956 photograph showing the foundations for the 1956-7 electric motor and reduction gear installation, presently Motor and Reduction Gear No. 1. View towards south wall of first floor. The original electrical switchboard is visible against this wall.

Photo #28 Credit MUNI.
INTERIOR VIEW TO SOUTHEAST ON FIRST FLOOR - 1956: Photocopy of November 1956 photograph showing southeast corner of the first floor of the powerhouse. View towards southeast. The winding sheaves are partially visible at the extreme left of the photograph. The original transformer equipment and switchboard are visible to the right of the column in the foreground.

Photo #29 Credit MUNI.
MOTOR AND REDUCTION GEAR NO. 1 - 1957: Photocopy of April 1957 photograph showing Motor and Reduction Gear No. 1. View towards

northwest on first floor of powerhouse. Note the engineer's shack located behind the motor, and the winding sheave partially visible on the far right of the photograph.

Photo #30 Credit MUNI.
INTERIOR VIEW TO SOUTHWEST ON FIRST FLOOR - 1958: Photocopy of March 1958 photograph showing southwest corner of the first floor of the powerhouse. View towards southwest. The smokestack is visible in the corner of the building. In front of the stack is the old boiler pit, covered by a concrete slab later in 1958.

Photo #31 Credit MUNI.
CABLE REWINDER - 1958: Photocopy of March 1958 photograph showing cable rewinder on the first floor of the Washington and Mason Streets powerhouse. View to north. Cable was wound onto this spool when removed from the street. This winder has since been replaced.

Photo #32 Credit BL.
VIEW TO SOUTHEAST OF WINDING MACHINERY - C.1960: Photocopy of c.1960 photograph showing the winding machinery and Motor and Reduction Gear No. 2 (visible on either side of the left-most column in the photograph). View towards southeast. The tension runs extend to the right out of the photograph.

Photo #33 Credit RDG.
SAN FRANCISCO - VIEW TO WEST C.1847: Photocopy of an engraving showing San Francisco c.1847, before the begining of landfill activity. View towards the west. Compare settlement patterns with CA-12-99, taken ten years later.

Photo #34 Credit BL.
VIEW TO SOUTH OF NOB HILL - 1856: Photocopy of 1856 photograph of Nob Hill taken from Telegraph Hill. View is roughly to the south. Housing density falls off markedly with increasing elevation.

Photo #35 Credit RDG.
VIEW NORTH FROM RUSSIAN HILL - 1862: Photocopy of an 1862 engraving looking north from Russian Hill. Western Addition lands are to the left of the park with the flagpole. Notice the relative lack of development in this district compared to the downtown area.

Photo #36 Credit RDG.
VIEW WEST FROM RUSSIAN HILL - 1862: Photocopy of an 1862 engraving looking west from Russian Hill towards the sparsely populated and developed Western Addition.

Photo #37 Credit RDG.
VIEW SOUTH AND WEST FROM RUSSIAN HILL - 1863: Photocopy of an 1863 engraving looking south and west from Rusian Hill. The Western Addition comprises most of the right half of the engraving.

Photo #38 Credit BL.
VIEW EAST ALONG MARKET STREET - 1865: Photocopy of 1865 photograph of Market Street. View towards east.

Photo #39 Credit RDG.
VIEW SOUTH FROM NOB HILL - 1860S: Photocopy of photograph taken in 1860s looking south from Nob Hill into the Mission District towards Mission Dolores, and Hayes Valley. Photograph taken before the introduction of horsecar lines into the area.

Photo #40 Credit RDG.
HAIGHT & STAYAN TERMINUS OF MARKET STREET CABLE - C. 1885: Photocopy of c.1885 photograph showing the terminus of the Market Street Cable Railway's Haight Street line at Haight and Stanyan Streets, near the entrance to Golden Gate Park. View towards the east looking down Haight Street. The car in the foreground is being turned around on the turntable. Note the almost total absence of women amongst this weekend throng, possibly due to the fact that the cars are advertising service to a baseball game in Golden Gate Park.

Photo #41 Credit RDG.
VIEW WEST ON UNION STREET AT STEINER - 1880: Photocopy of 1880 photograph looking west on Union Street at Steiner. This intersection was the terminus of the recently completed Presidio & Ferries Railroad.

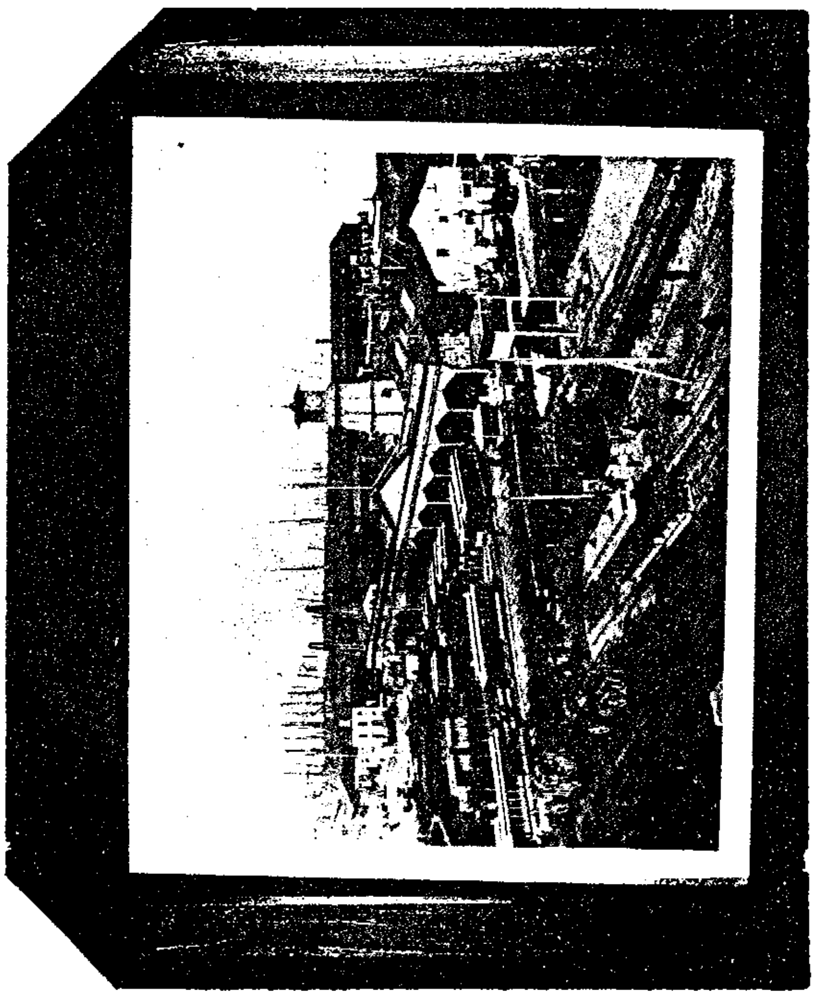
Photo #42 Credit RDG.
VIEW TO SOUTHWEST AT POWELL AND CALIFORNIA STREETS - 1883: Photocopy of 1883 photograph showing a California Street Cable Railroad cable car passing in front of the Stanford (left) and Hopkins Mansions atop Nob Hill. View is towards the southwest from the intersection of Powell and California Streets.

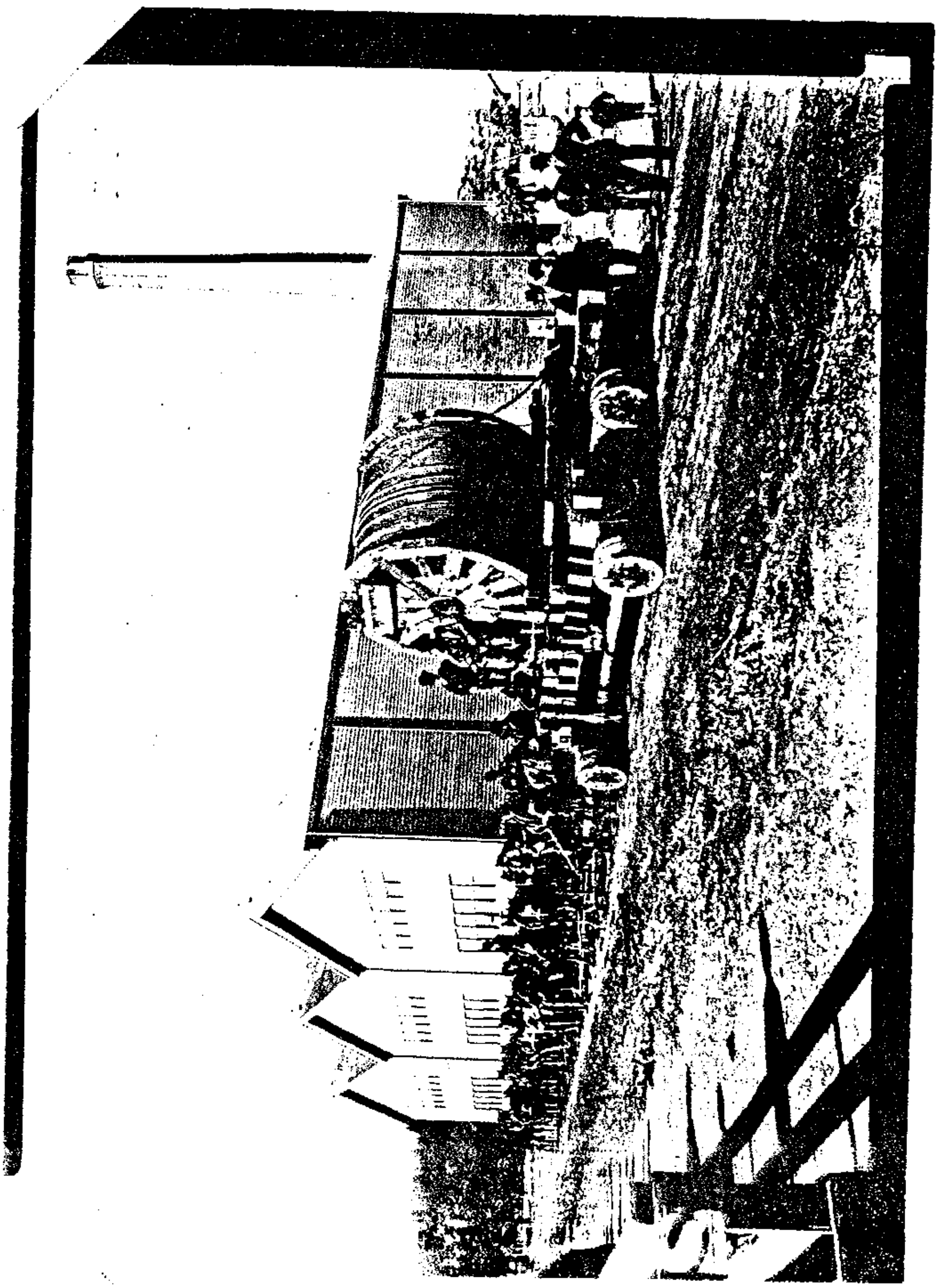
Photo #43 Credit RDG.
VAN NESS TERMINUS OF THE CLAY STREET HILL RAILROAD - 1880S: Photocopy of photograph taken in the 1880s of the Van Ness Avenue terminus of the Clay Street Hill Railroad. View towards the northwest. Note the rather undeveloped appearance of the area.

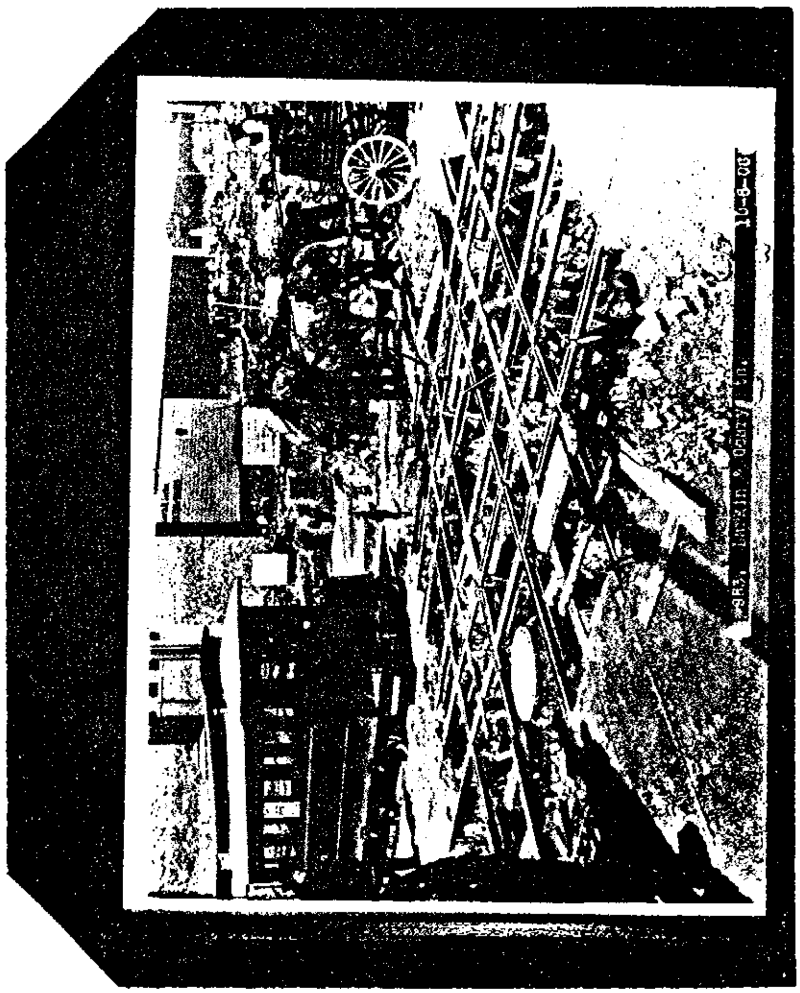
Photo #44 Credit RDG.
ADVERTISEMENT FOR HAYES PARK - 1880S: Photocopy of an 1880s advertisement for Hayes Park. The copy notes the easy accessibility of the pavilion and garden via cable car routes.

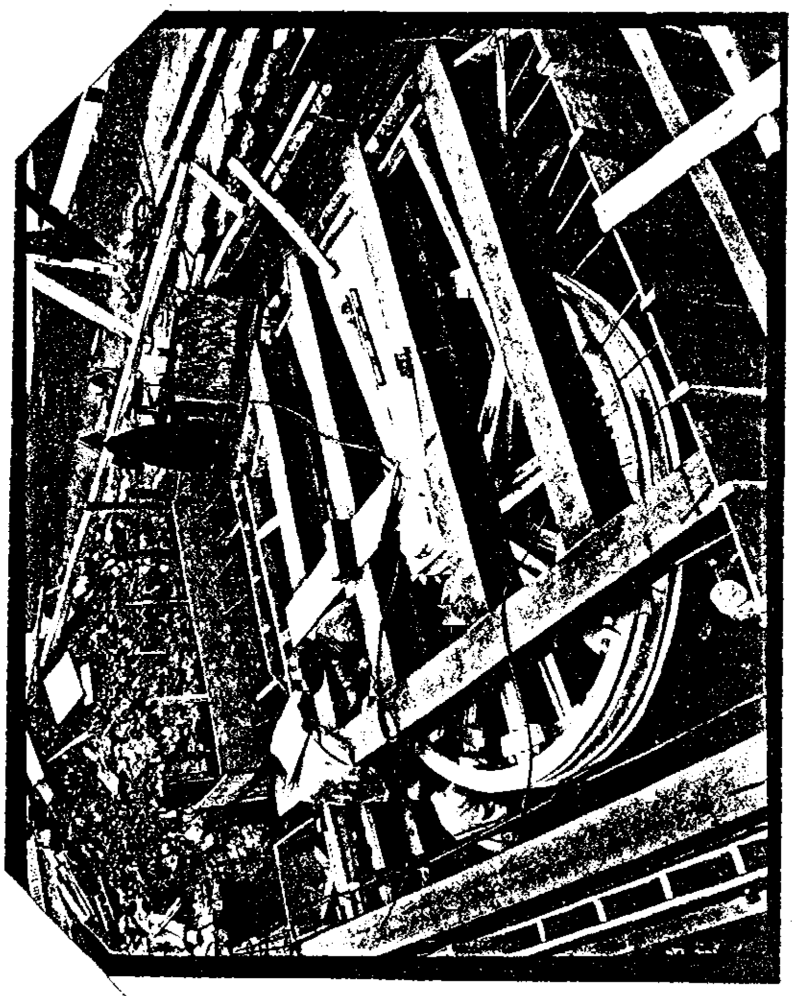
Photo #45 Credit RDG.
ADVERTISEMENT FOR SUTRO HEIGHTS - 1880S: Photocopy of an 1880s advertisement for the Sutro Heights area. The Powell and Jackson Street cable cars receive top billing.

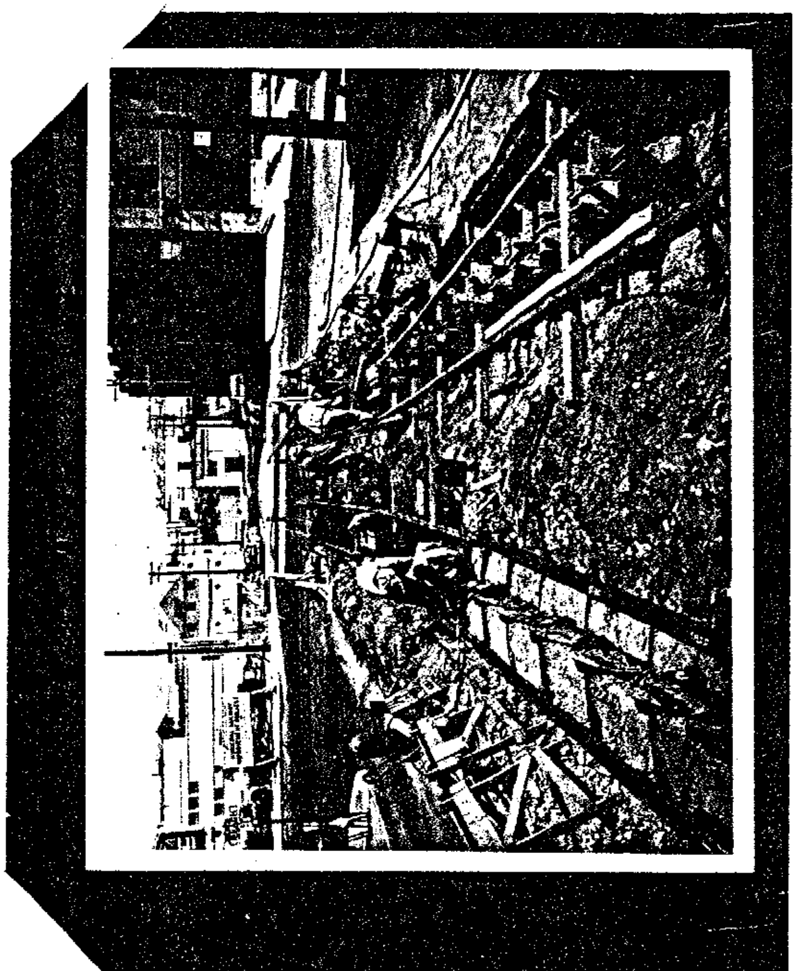
Photo #46 Credit BL.
ADVERTISEMENT FOR GOLDEN GATE PARK - 1880S: Photocopy of an 1880s advertisement for Golden Gate Park printed by the Market Street Cable Railway.

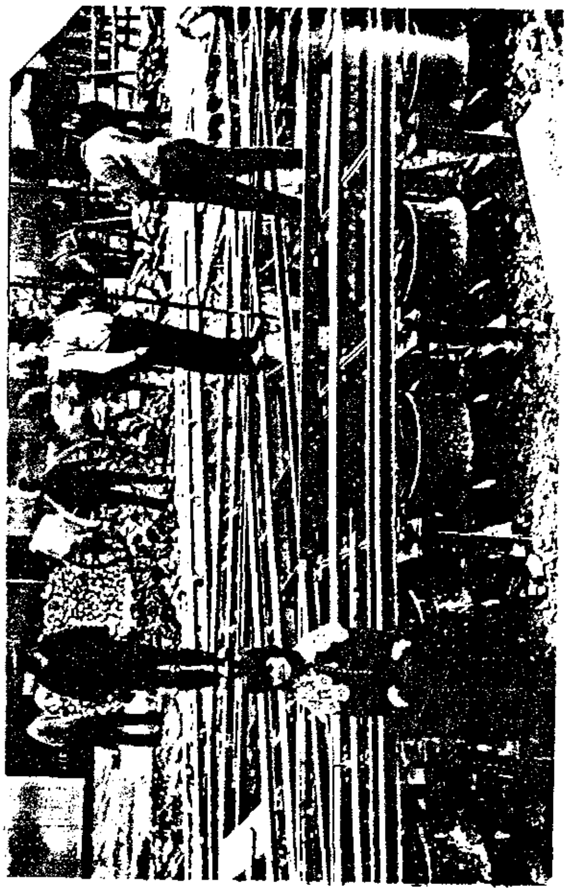












these described for other lines, and they are also provided with a slot brake which is operated by means of a

also exchanged with one foreign line, and any excess are redeemed at two and a half cents each. By means

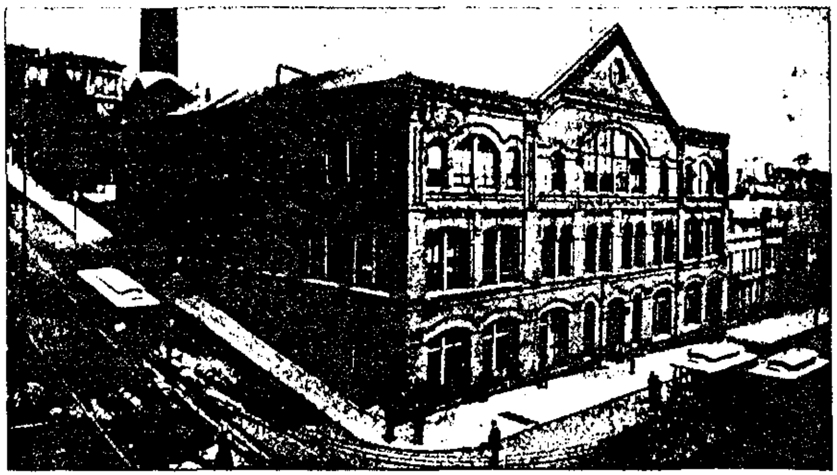
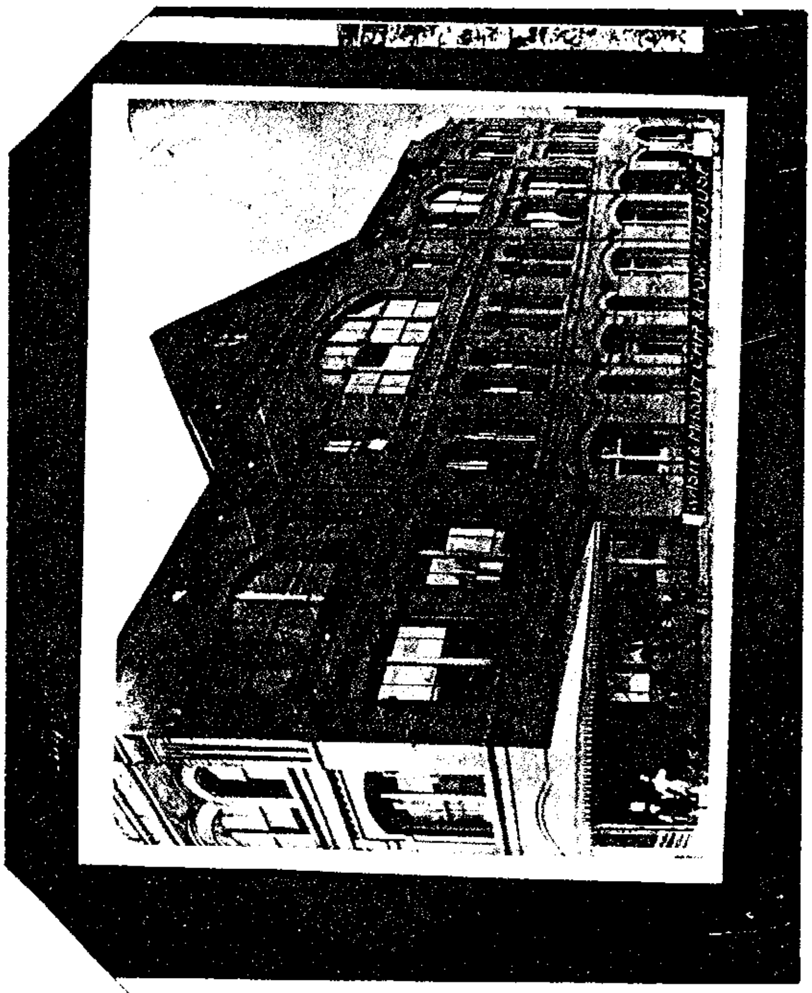
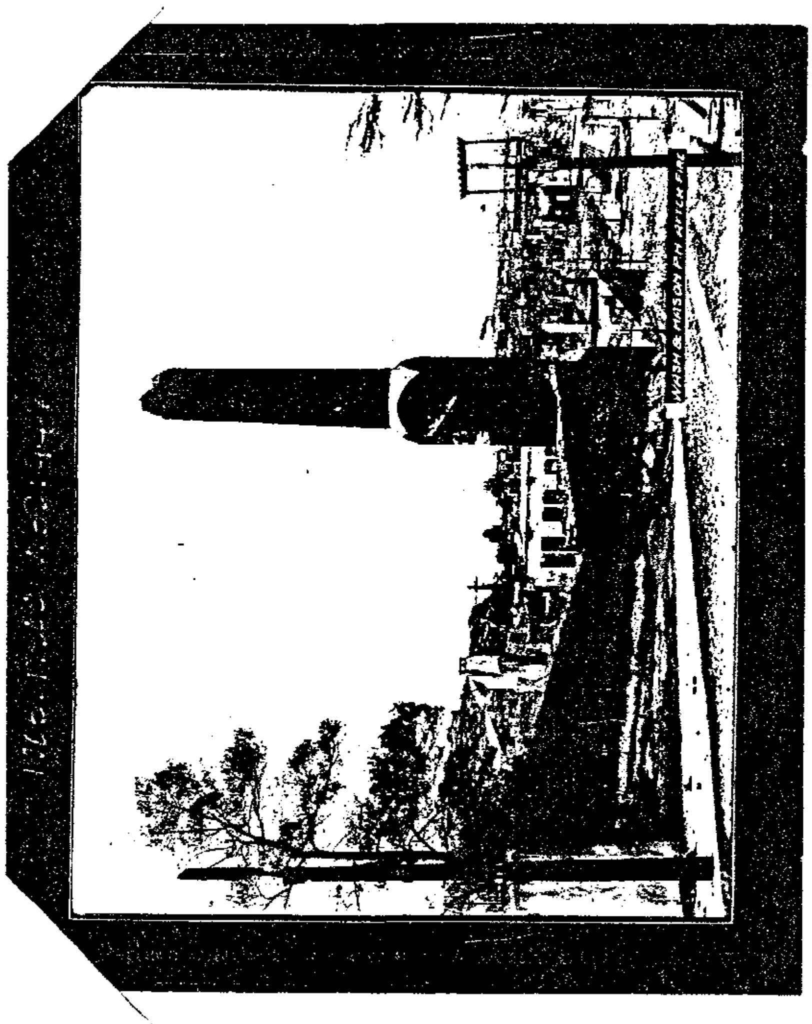


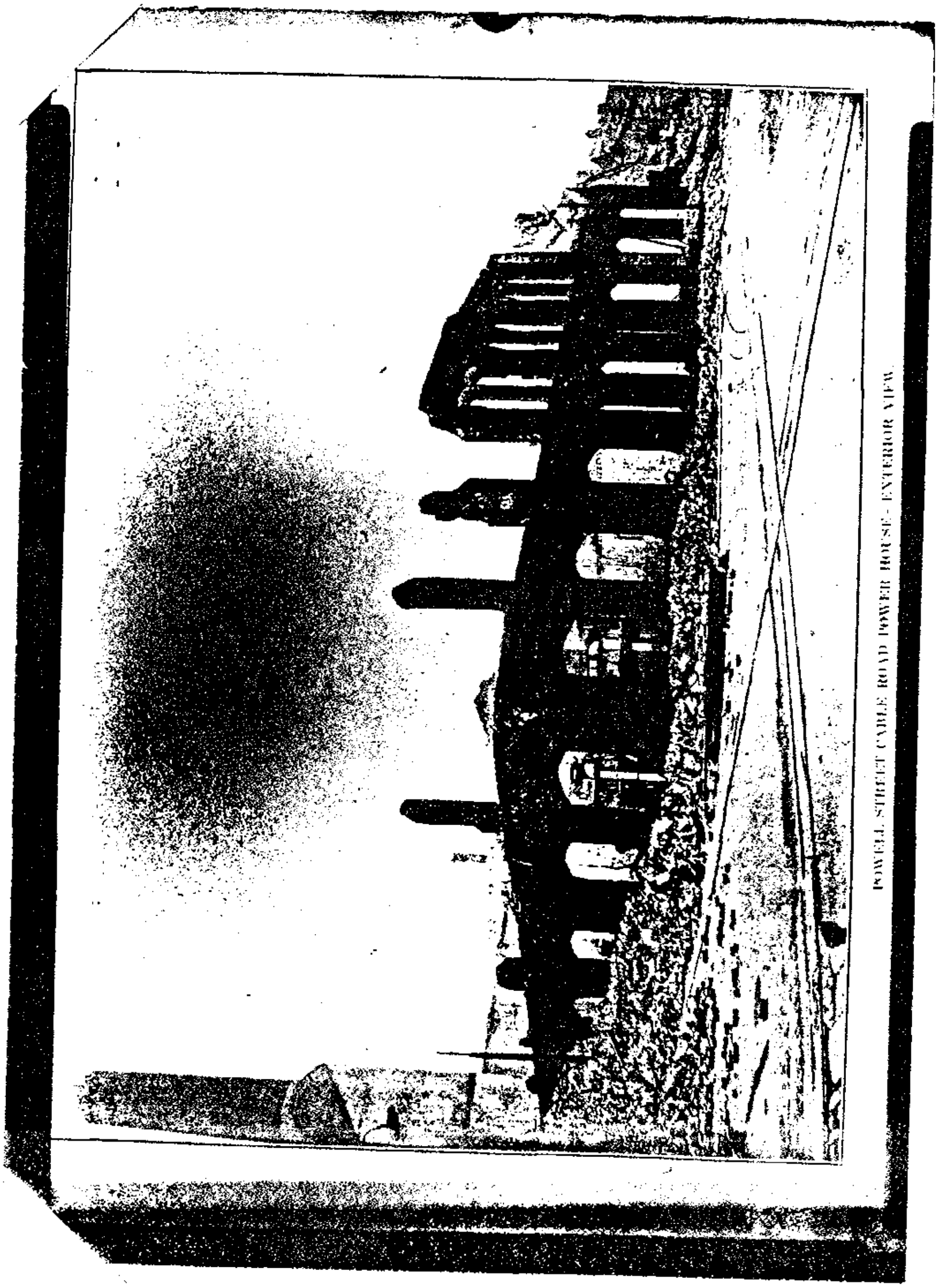
FIG. 28.—POWER STATION—FERRIES & CLIFF HOUSE RAILWAY, SAN FRANCISCO

lever by the gripman. This brake consists of a wedge shaped shoe of forged steel about twenty-four inches in length, five inches deep, and a little wider than the slot at

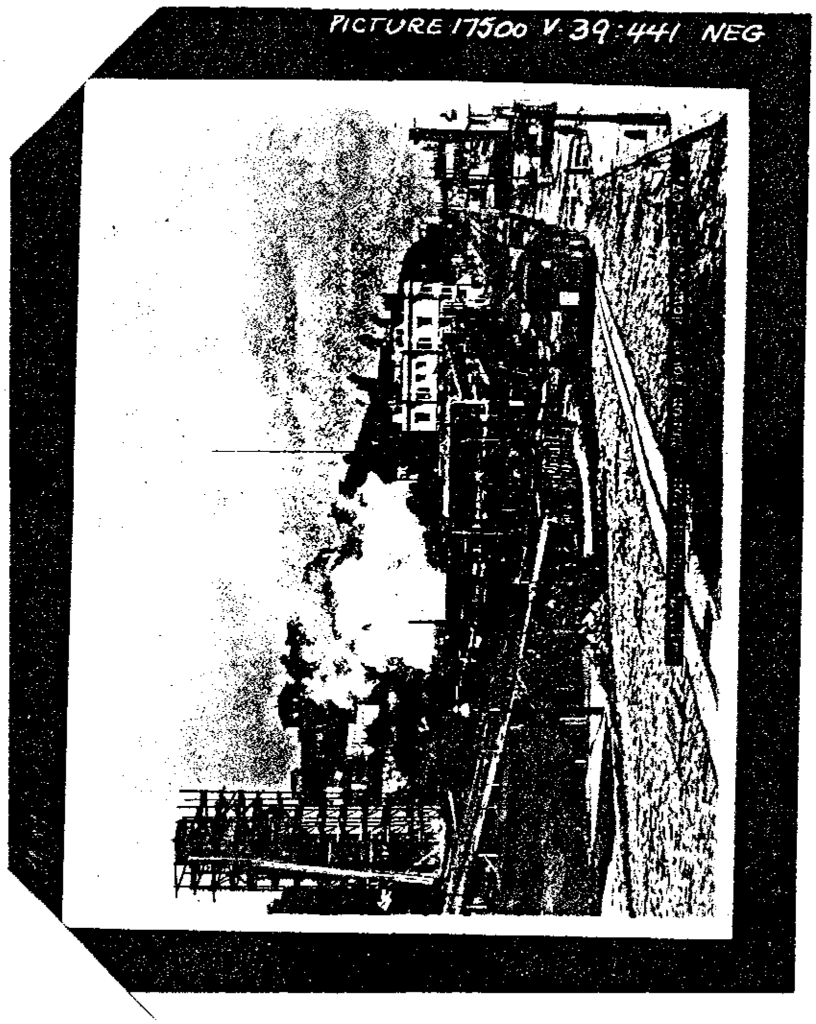
transfers a continuous ride of six miles may be had on company's system, and twelve miles in connection with foreign line. Employes are allowed to ride on their bad

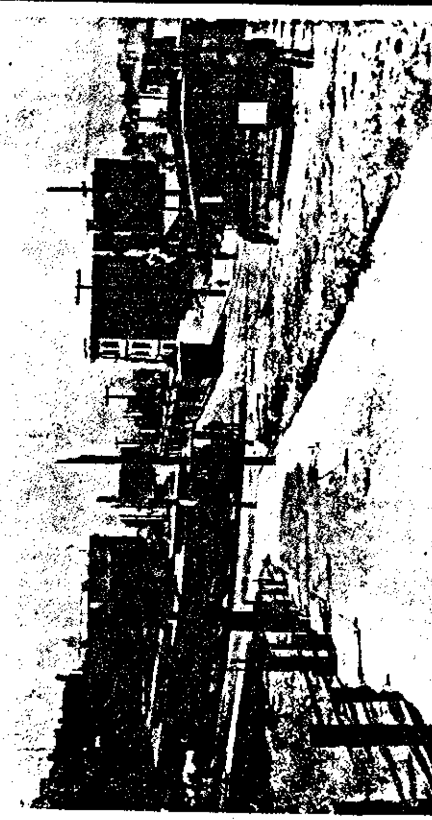






POWELL STREET CABLE ROAD POWER HOUSE - EXTERIOR VIEW.


PICTURE 17500 V.39:441 NEG



MASON AND WASHINGTON STREETS. 1906

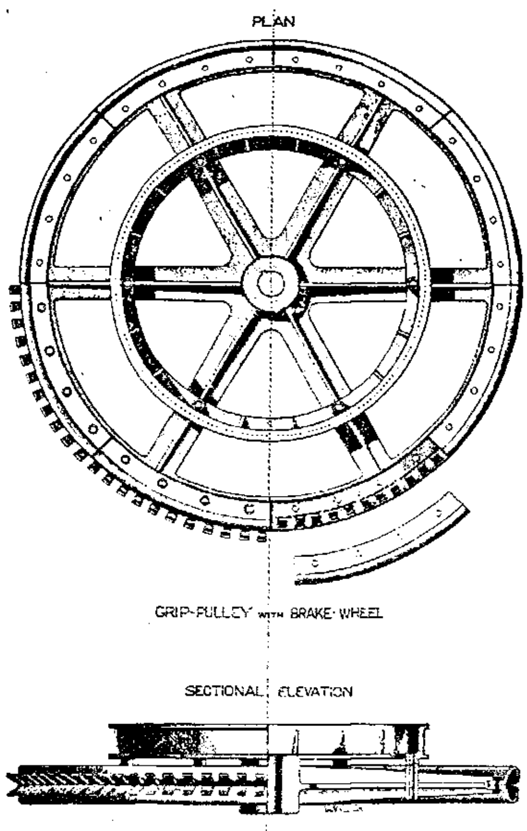
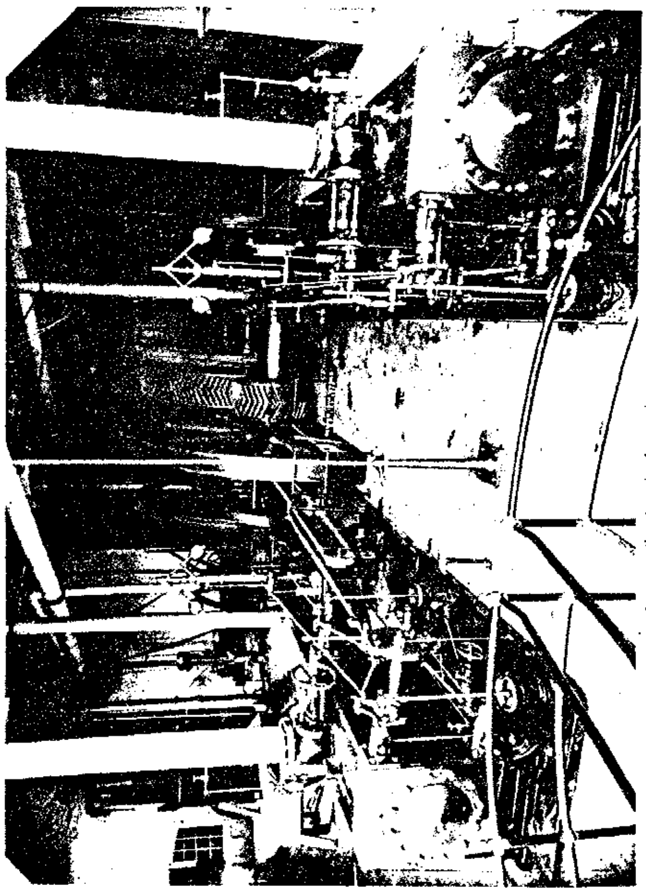
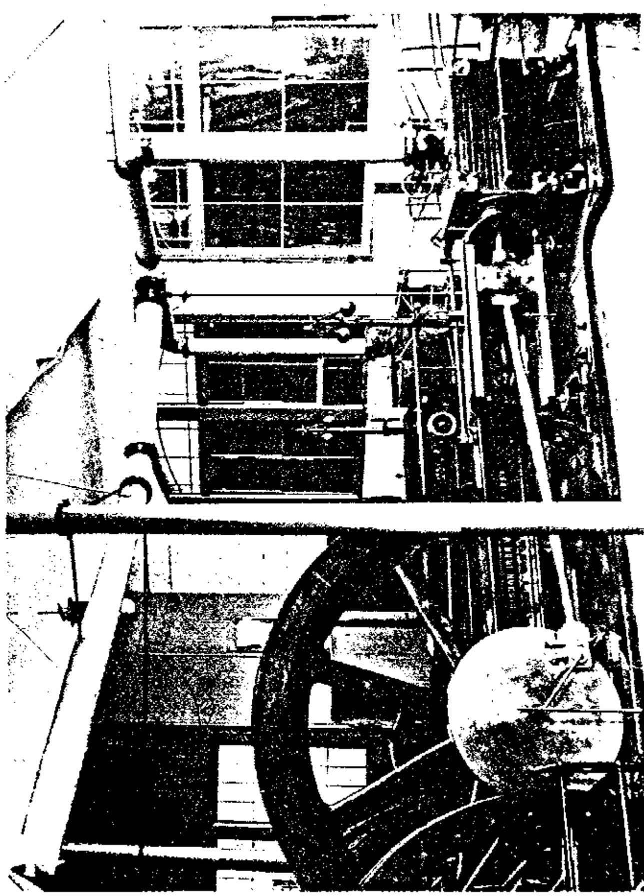
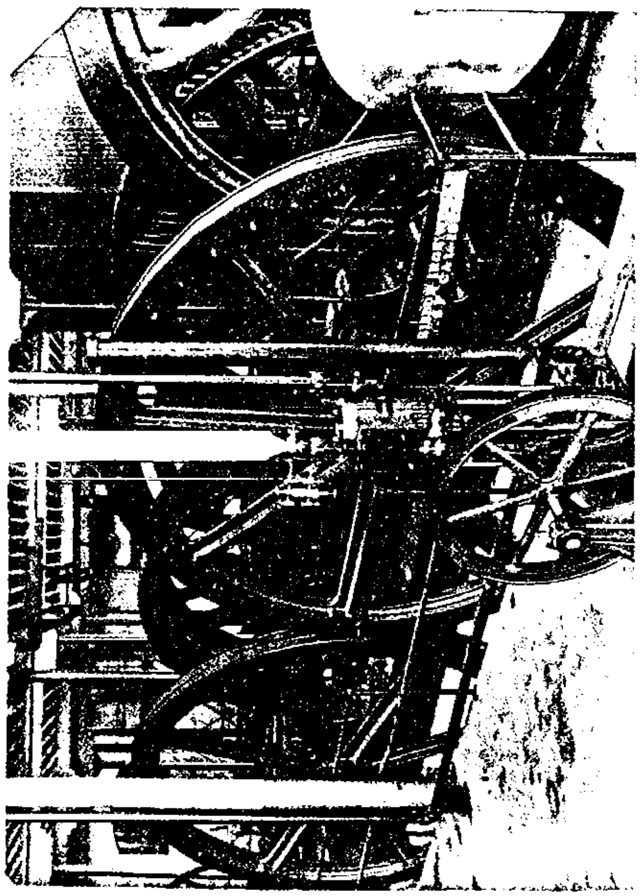
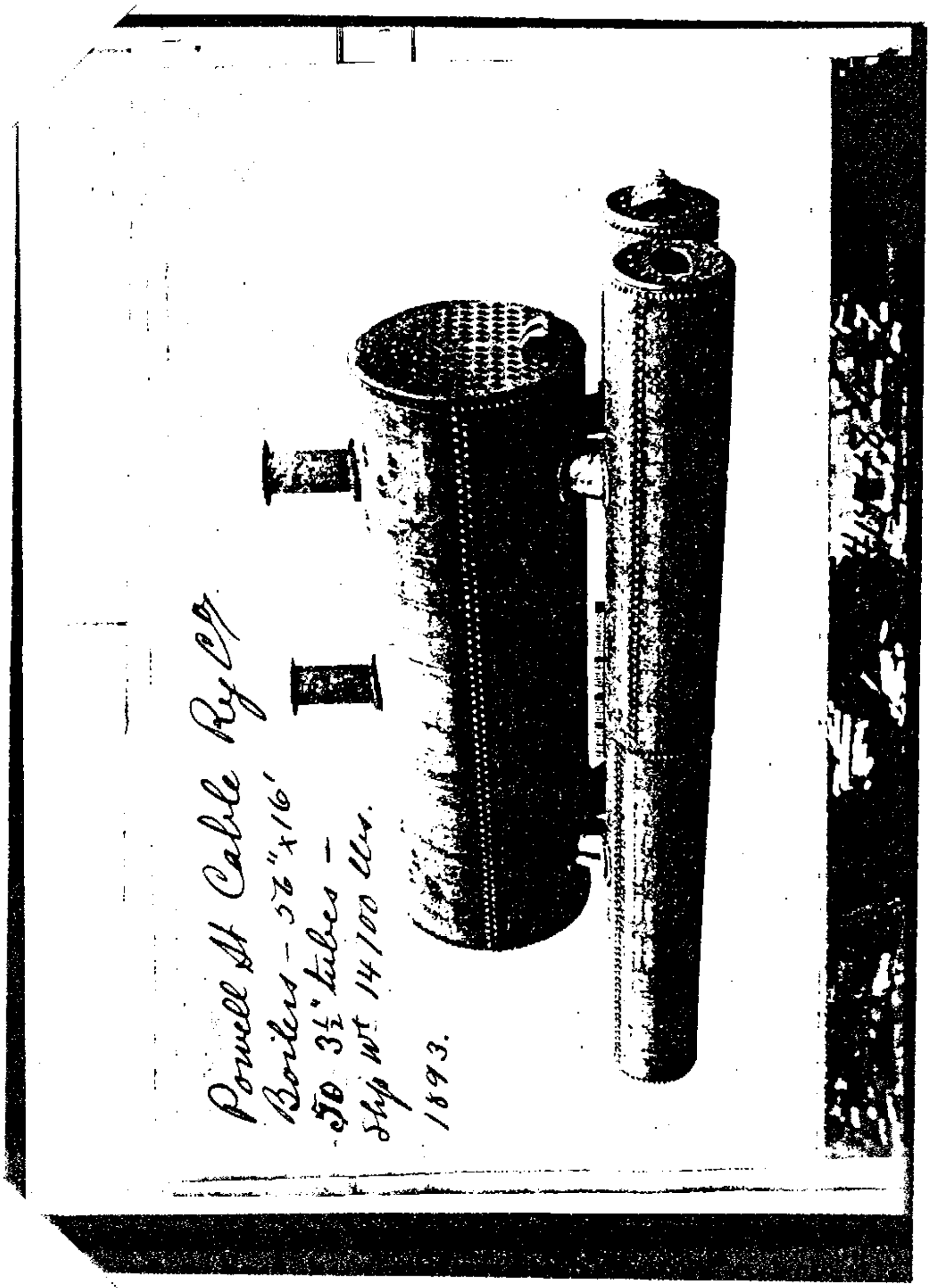


Fig. 7.








Powell St Cable Ry Co
Boilers - 56"x16'
50 3½" tubes -
Ship wt 14100 lbs.
1893.

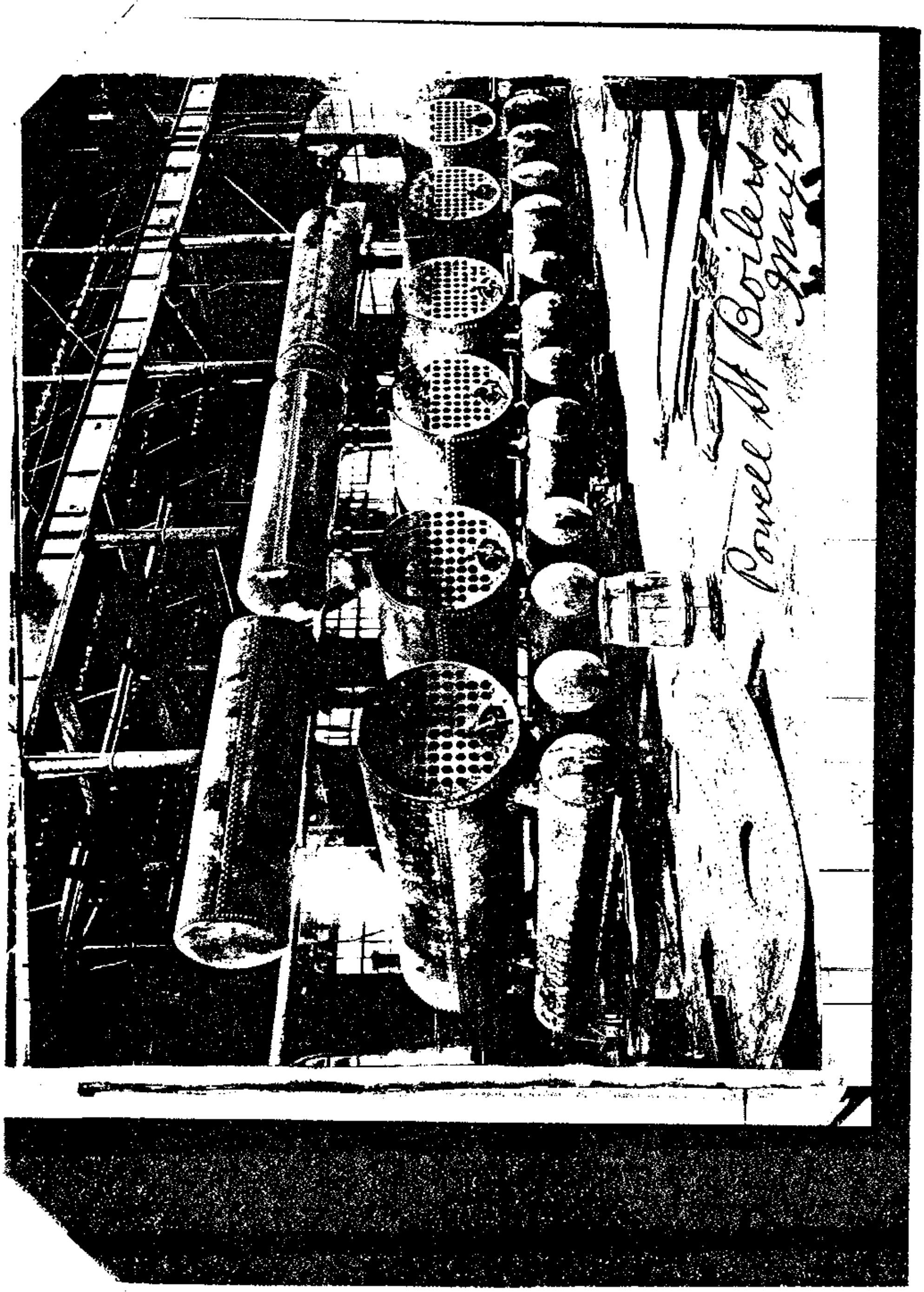
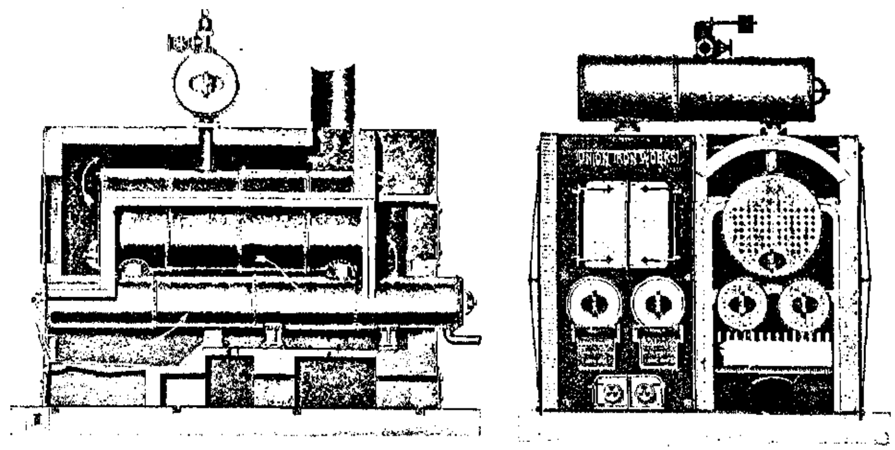
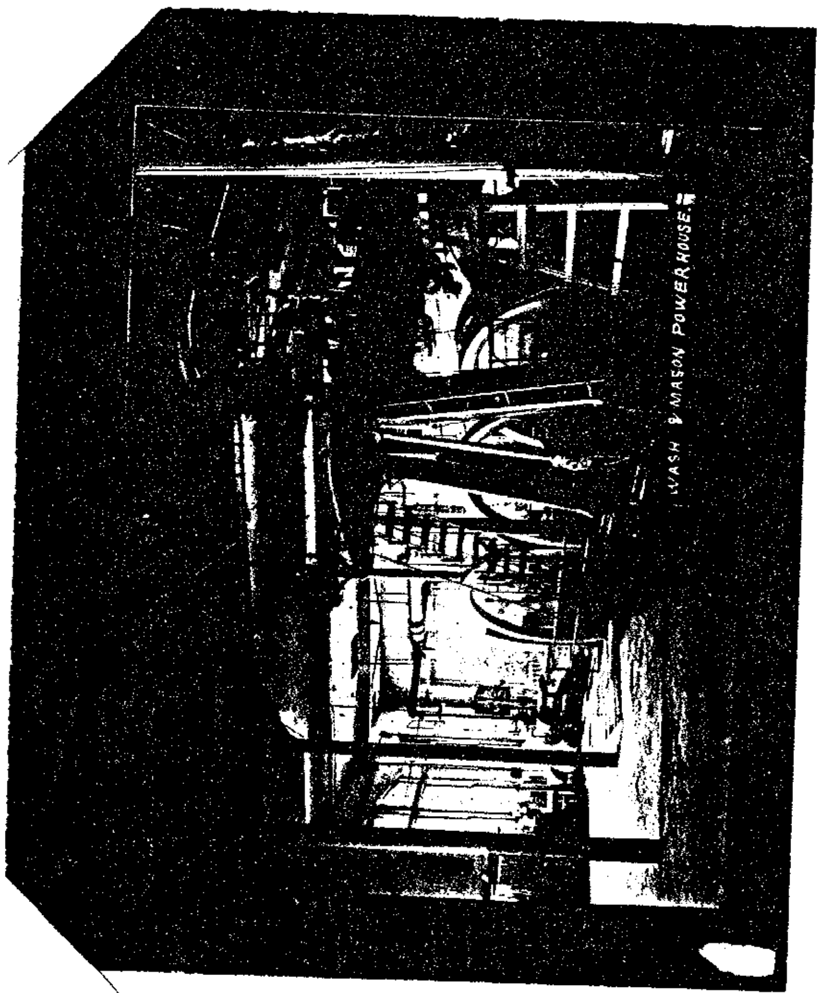

Powell St Boilers
May 44

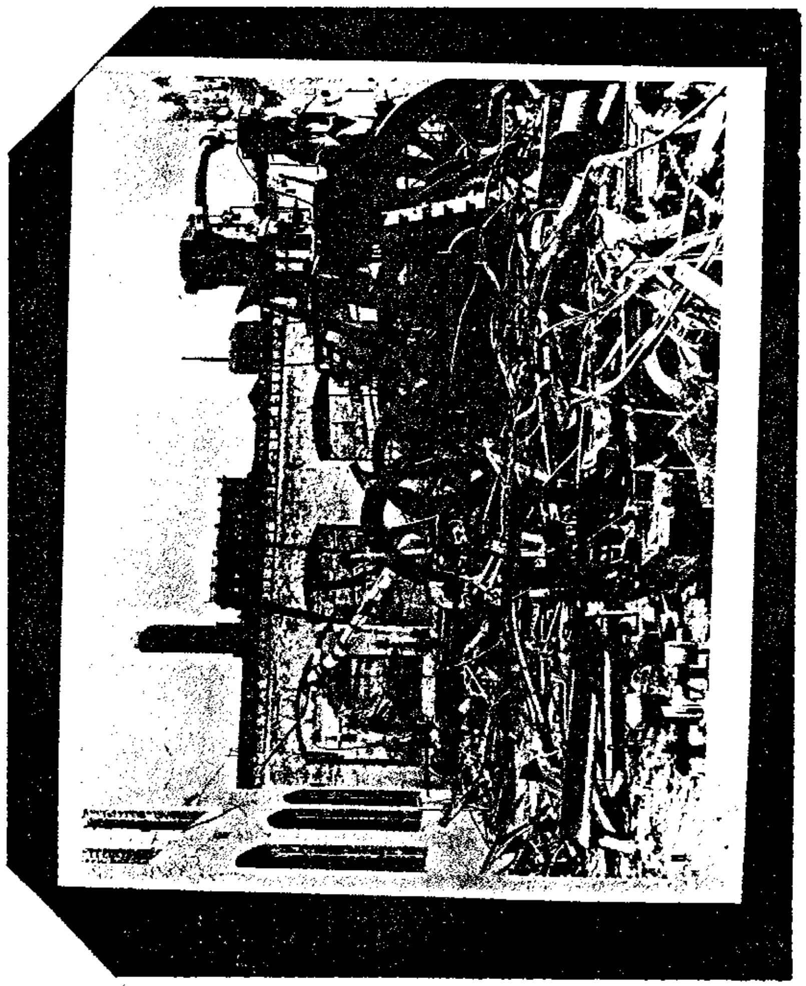
PLATE No. 37.

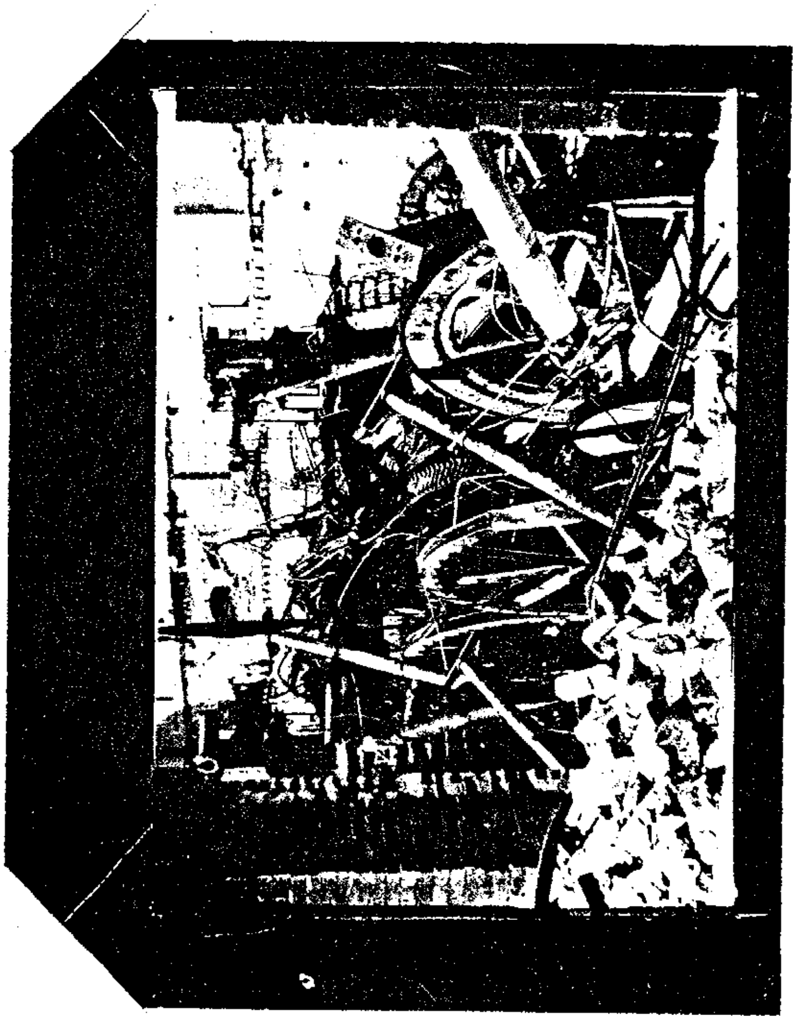


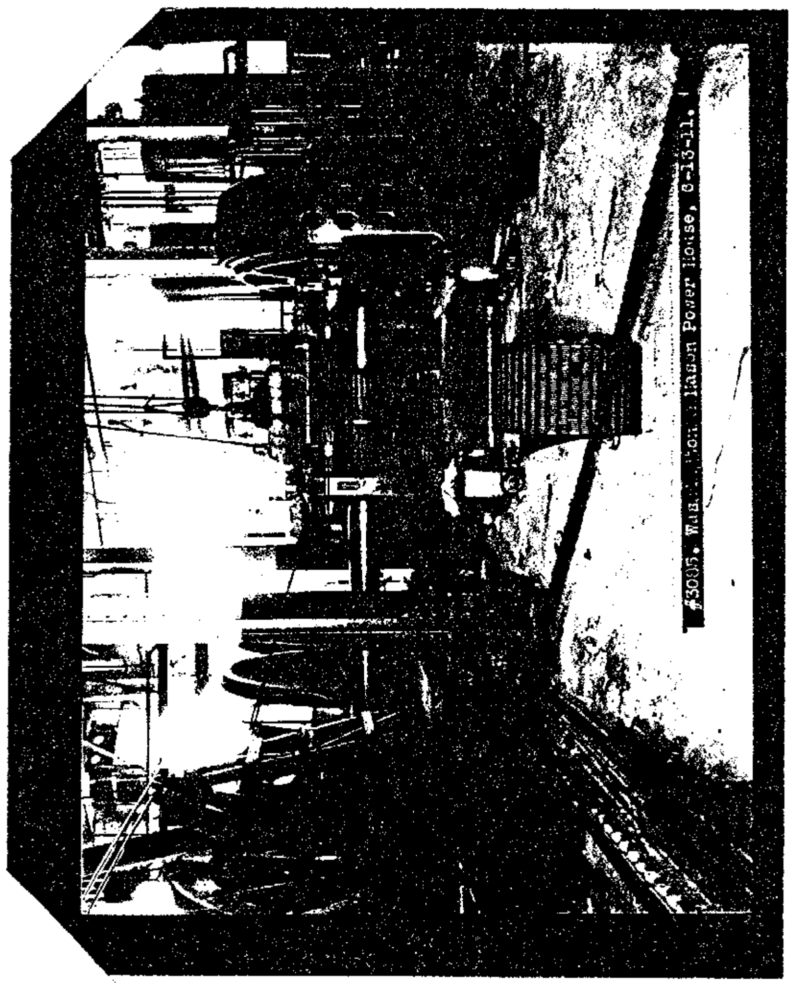
Elephant Boilers.

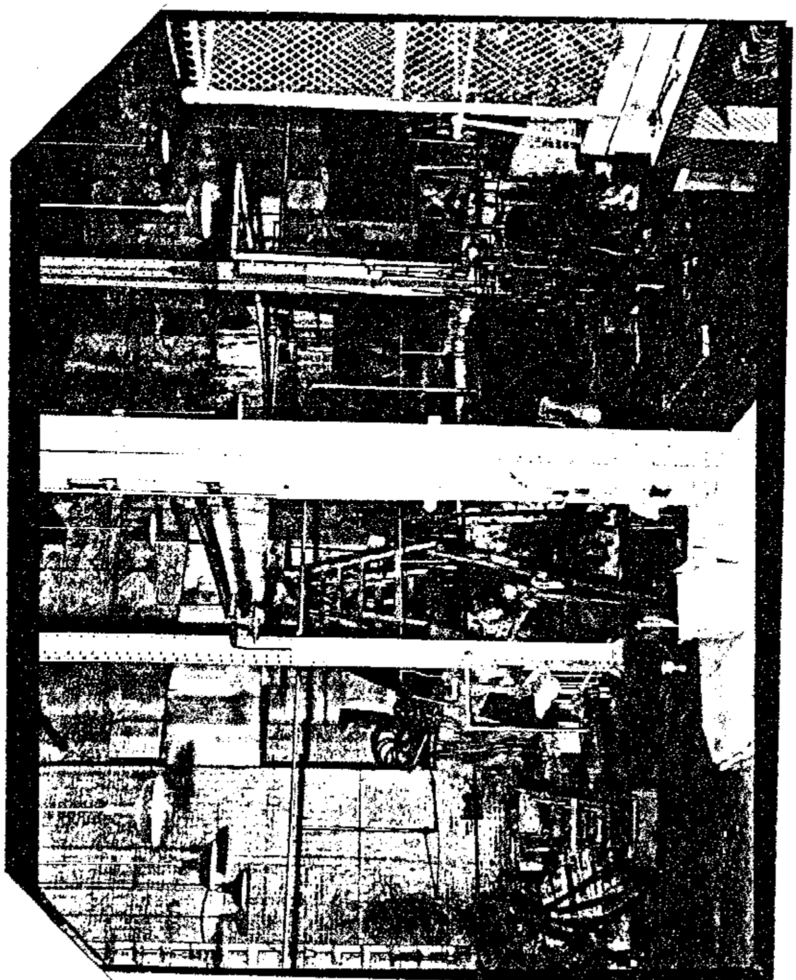
IN USE AT SUTTER STREET CABLE PLANT, SAN FRANCISCO.

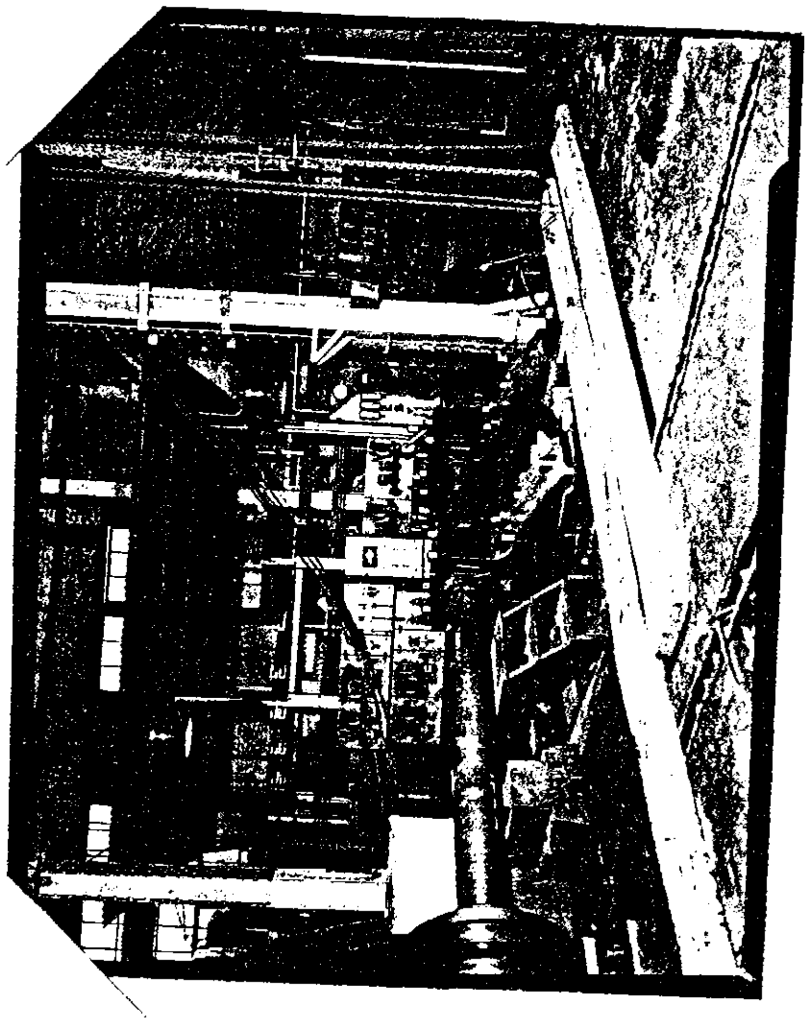

WASH & MASON POWER HOUSE.

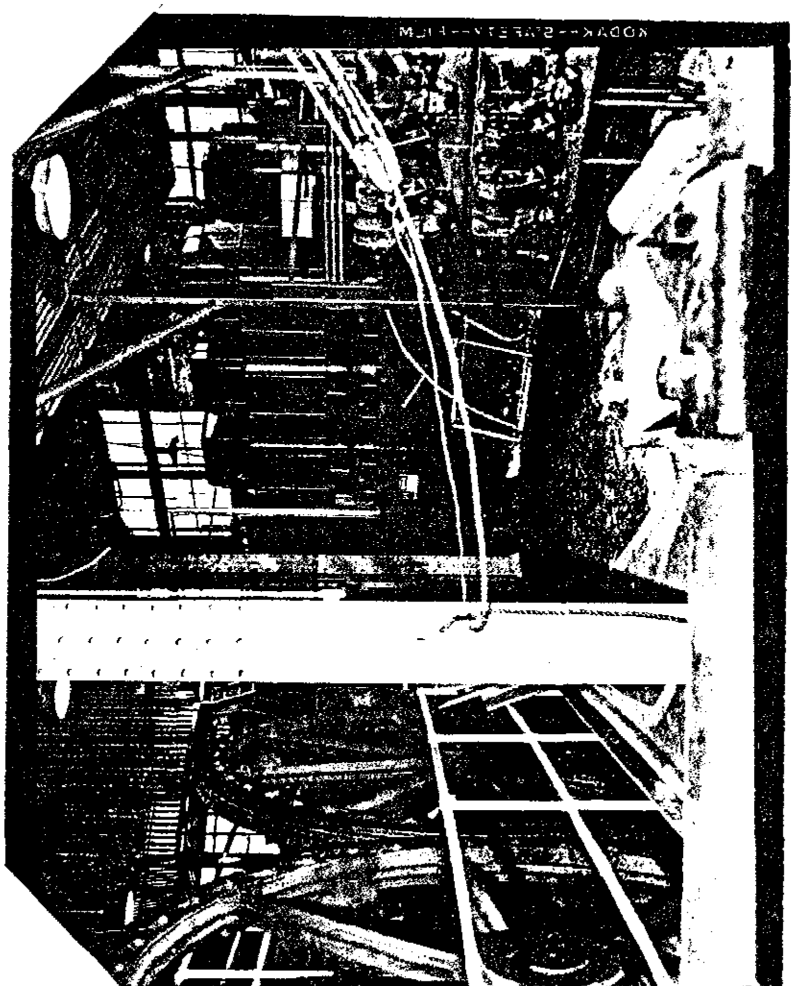


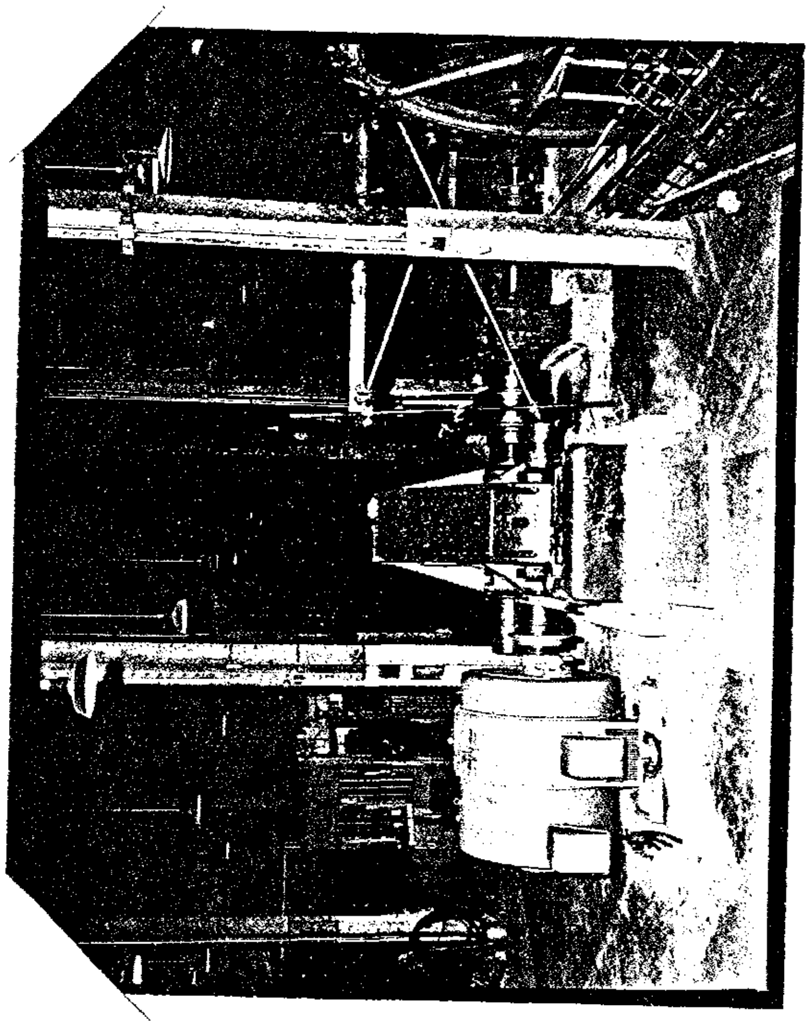


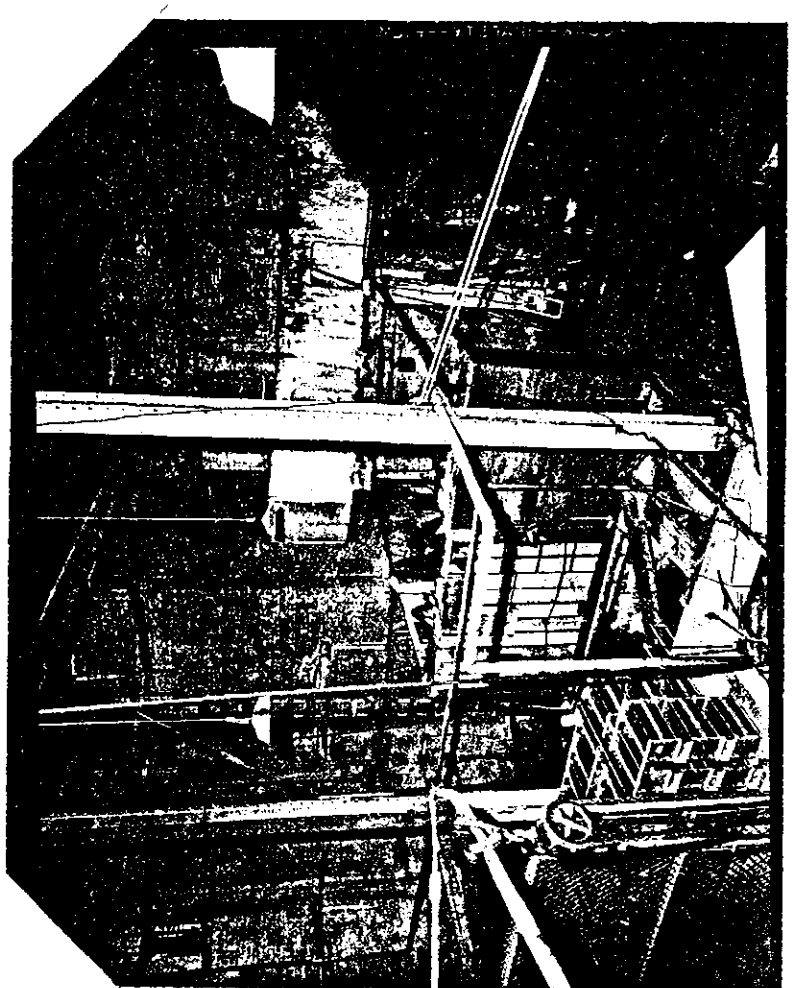

#3005.
Power House, 8-13-11.

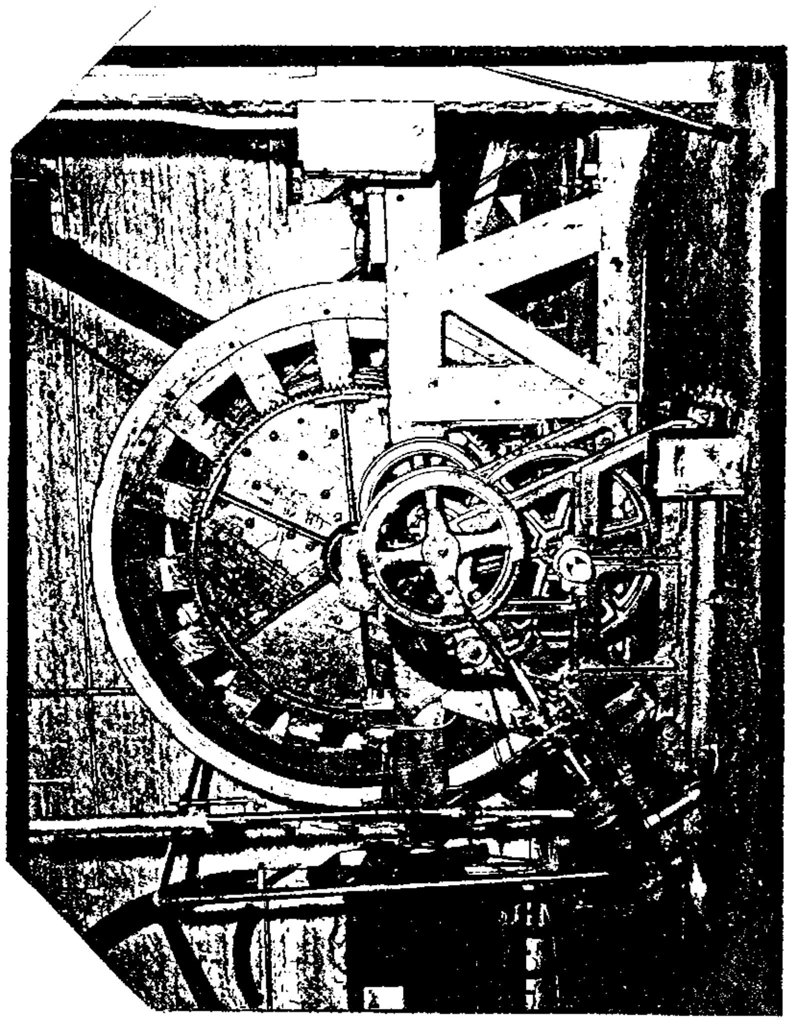




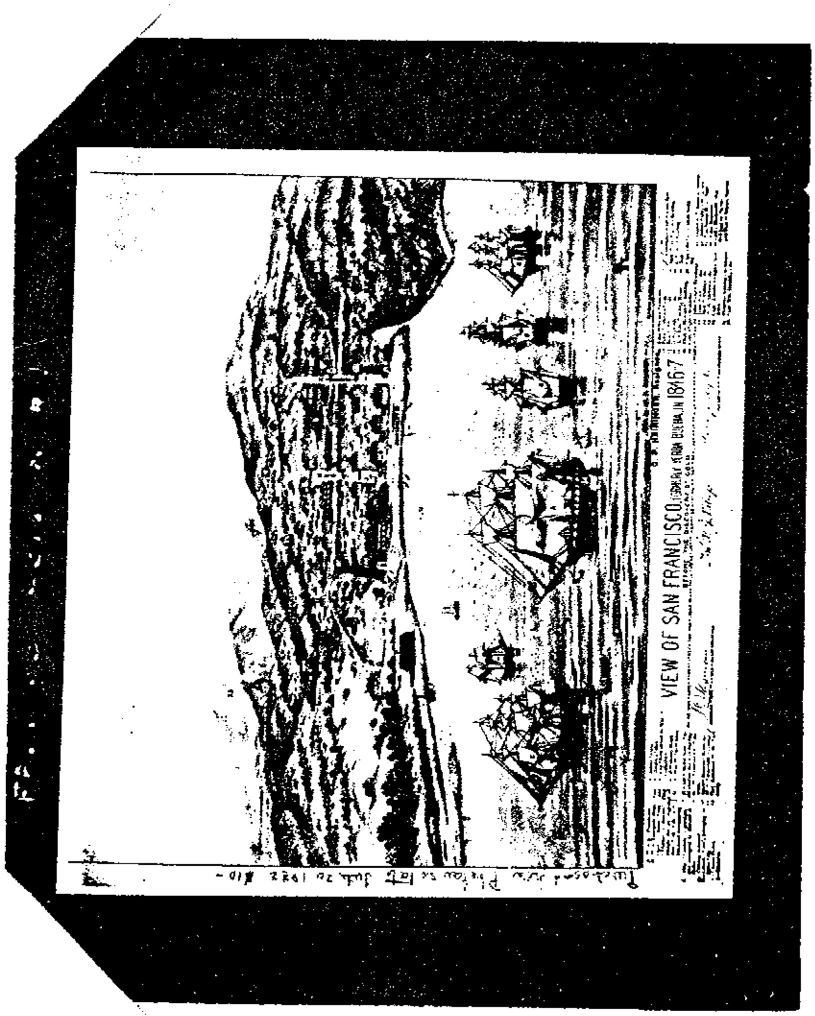




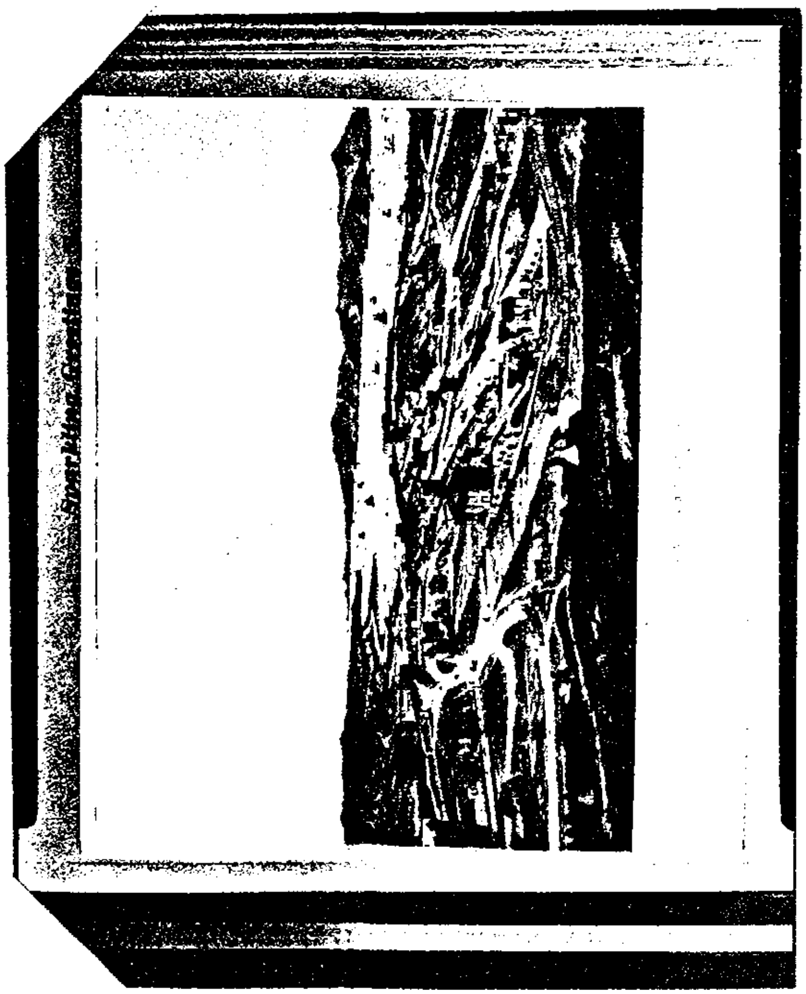


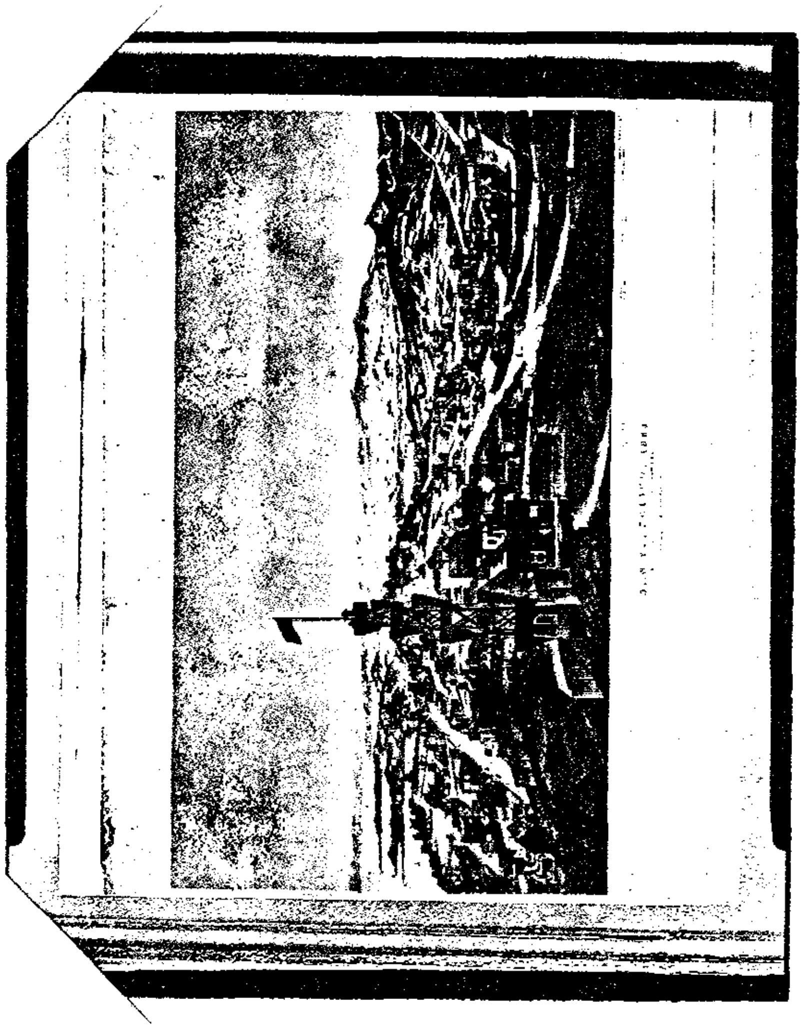


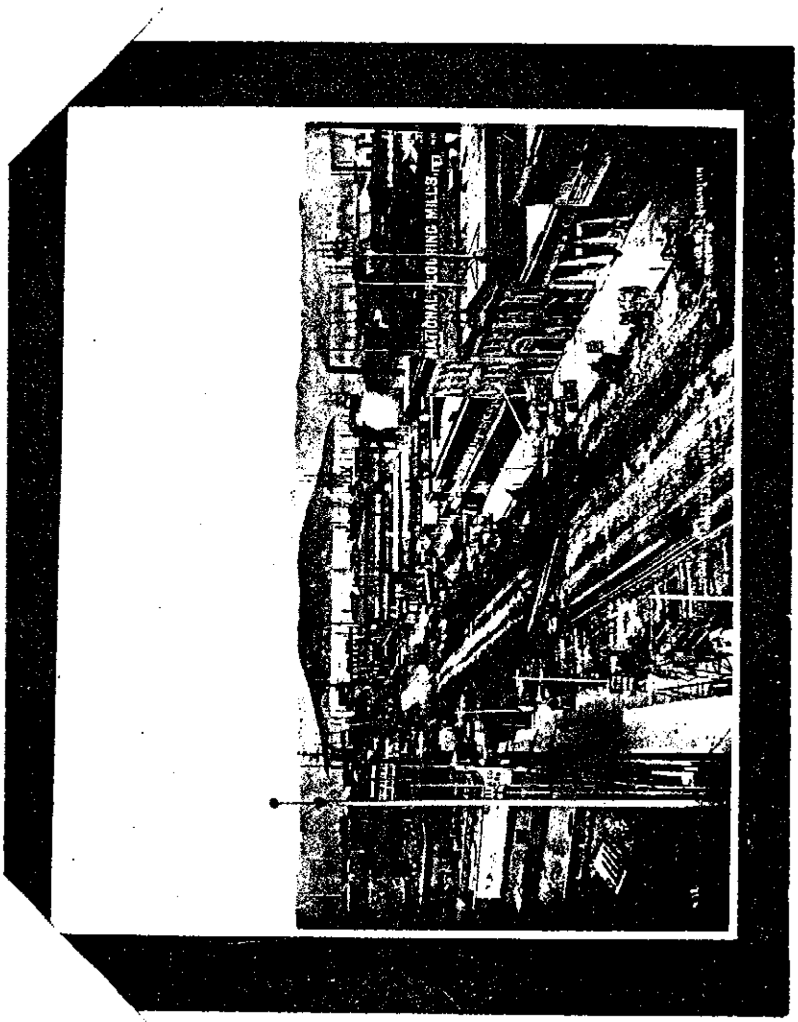
All four cable car lines are driven by a single 750-h. p. motor here at the Washington and Mason power plant. You're looking at the giant 12-foot cable-winders (note cables running off top rims), which connect with a moveable carriage at other end of building to keep the cable taut. An alarm bell goes off in case one of the cables should snap

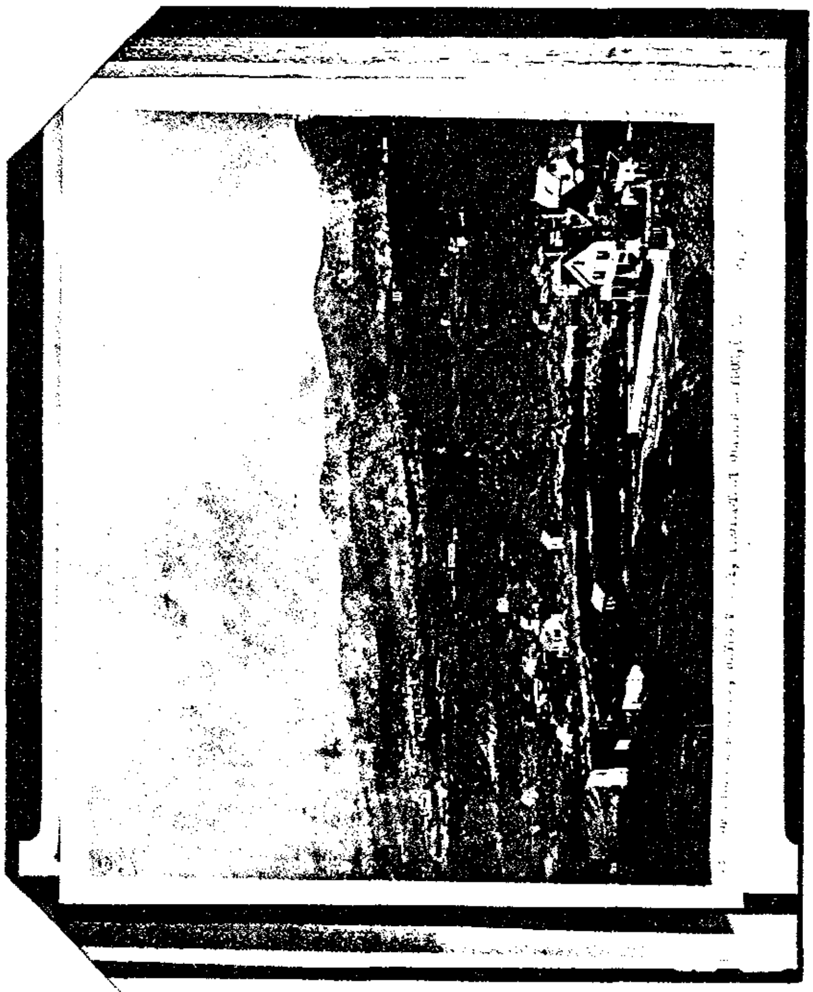

VIEW OF SAN FRANCISCO

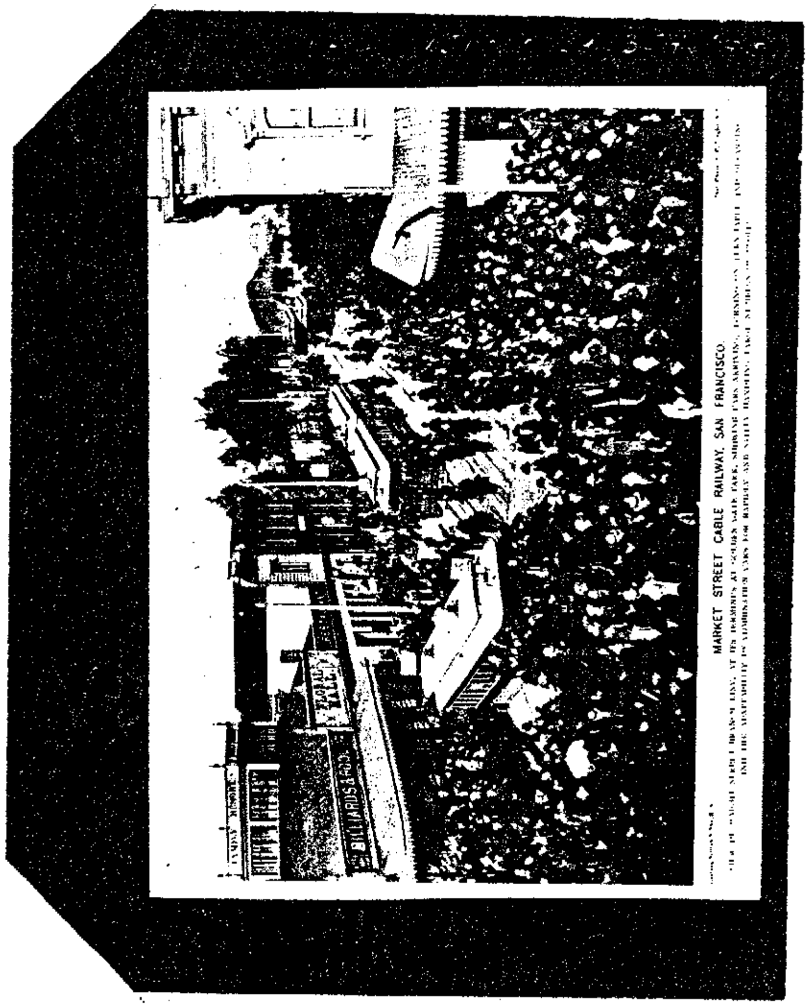
Glowing Candles



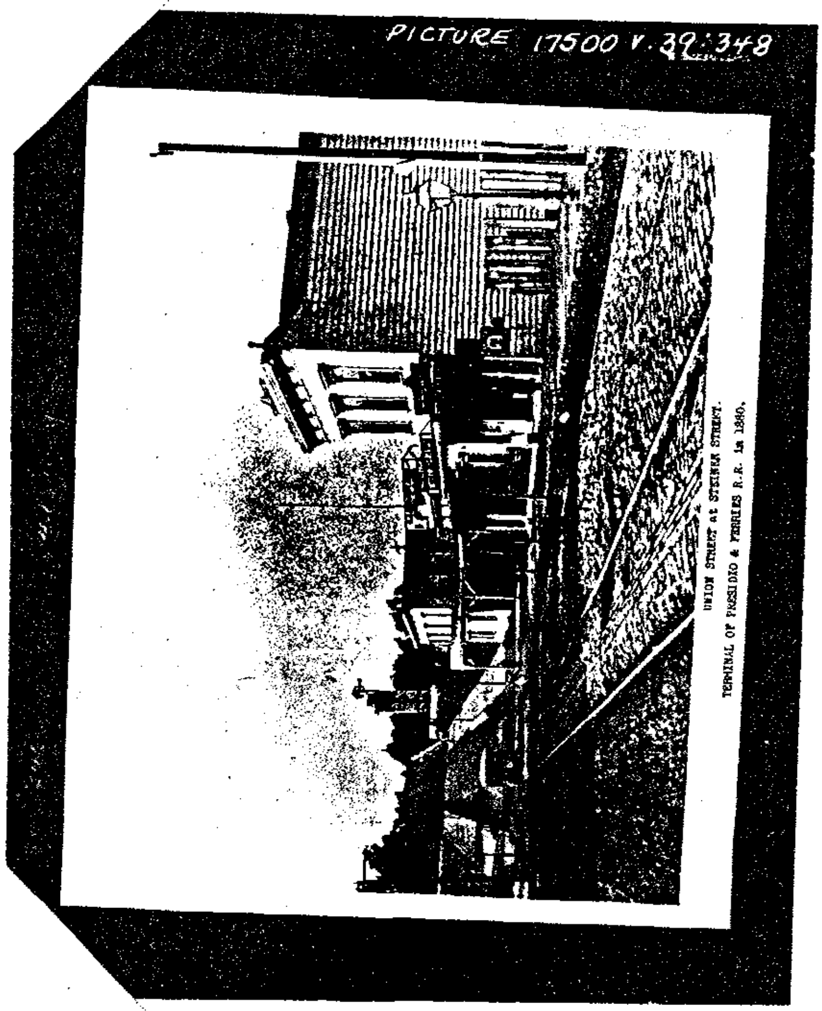




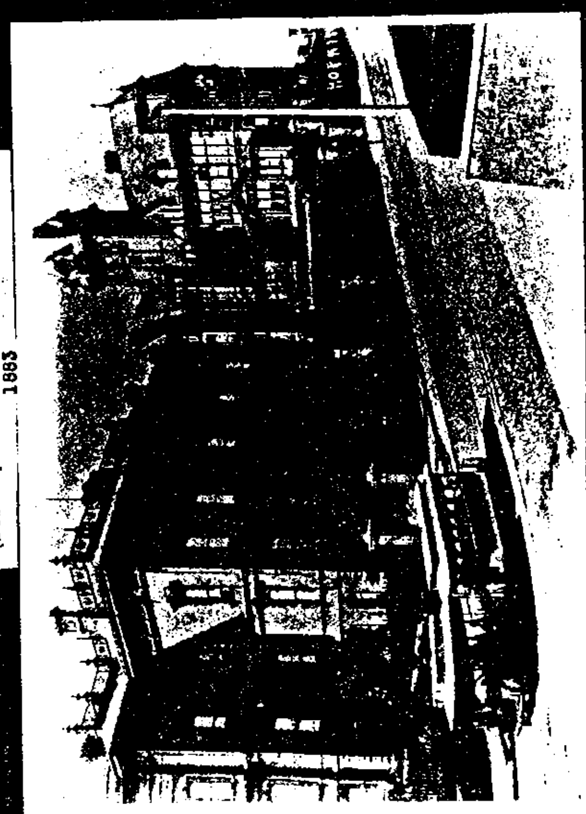




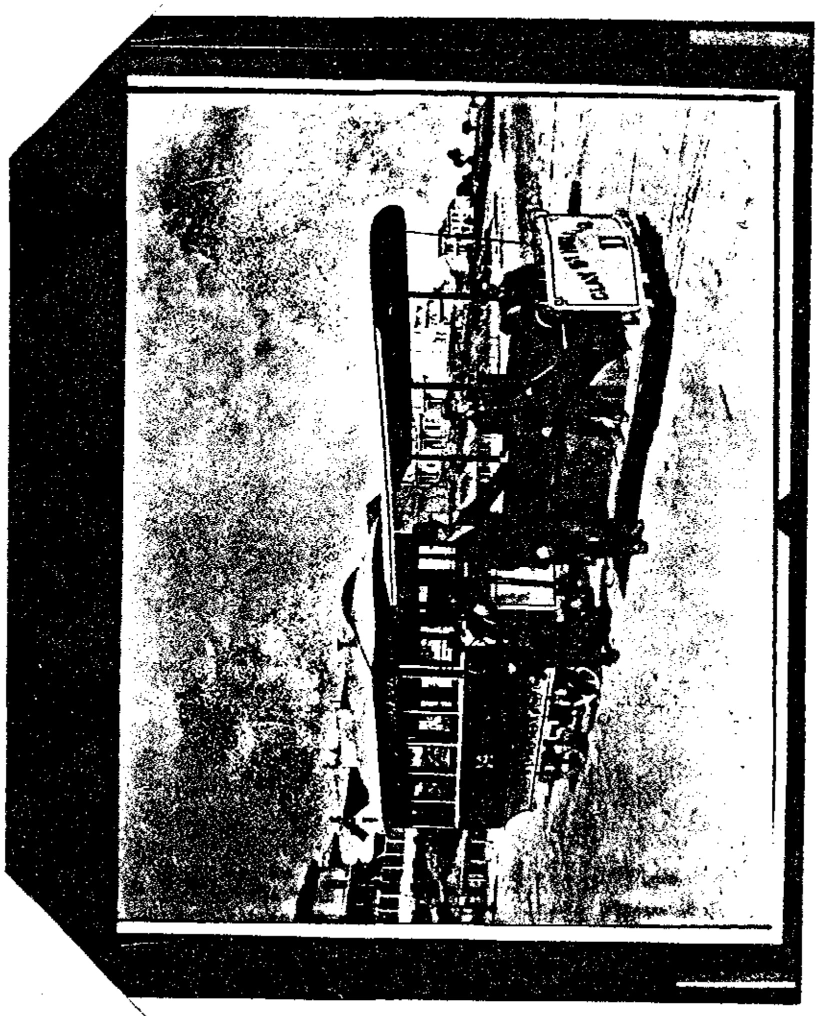
MARKET STREET CABLE RAILWAY, SAN FRANCISCO.

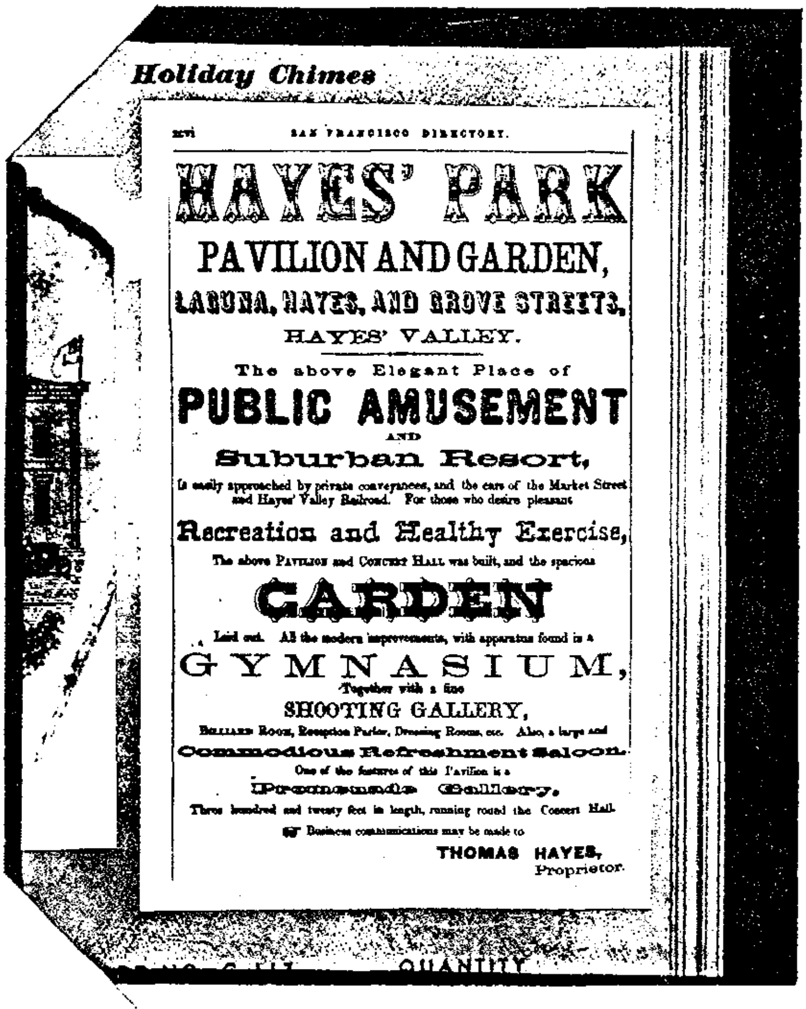


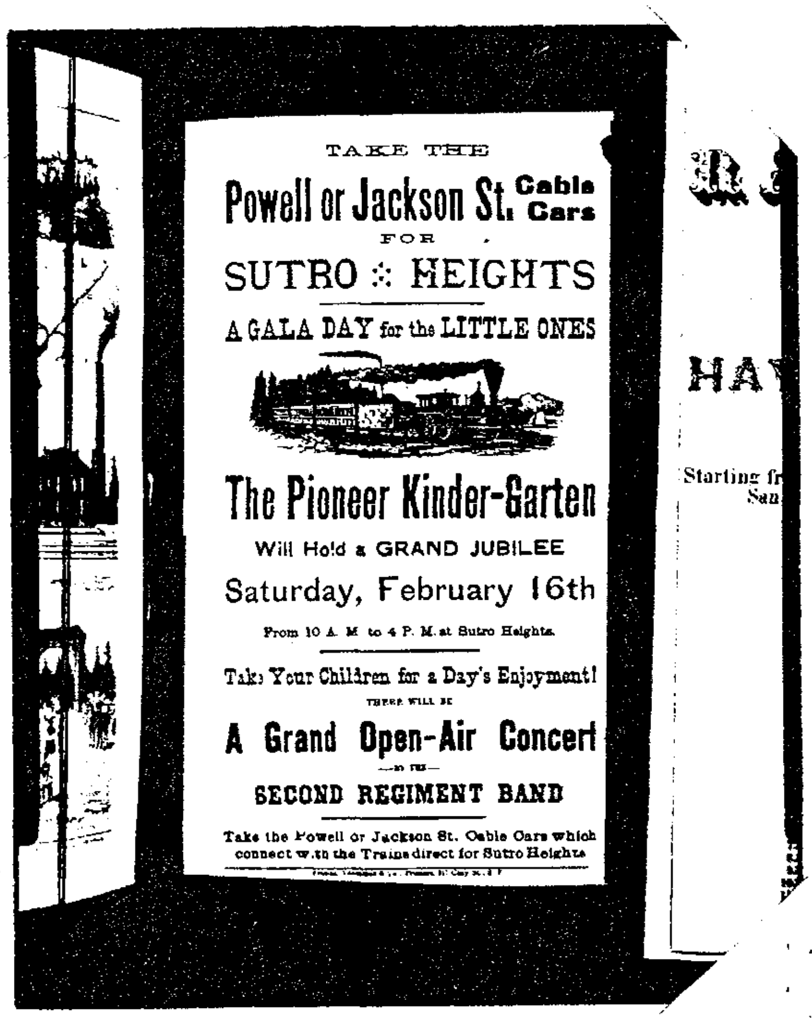
UNION STREET at STEINER STREET.
TERMINAL OF PRESIDIO & FERRIES R.R. in 1880.



(BOTTOM): CALIFORNIA & POWELL STS.
1883




Holiday Chimes
xvi SAN FRANCISCO DIRECTORY.
HAYES' PARK
PAVILION AND GARDEN,
LAGUNA, HAYES, AND GROVE STREETS,
HAYES' VALLEY.
The above Elegant Place of
PUBLIC AMUSEMENT
AND
Suburban Resort,
Is easily approached by private conveyances, and the cars of the Market Street and Hayes' Valley Railroad. For those who desire pleasant
Recreation and Healthy Exercise,
The above Pavilion and Concert Hall was built, and the spacious
GARDEN
Laid out. All the modern improvements, with apparatus found in a
GYMNASIUM,
Together with a fine
SHOOTING GALLERY,
Billiard Room, Reception Parlor, Dressing Rooms, etc. Also, a large and
Commodious Refreshment Saloon.
One of the features of this Pavilion is a
Promenade Gallery,
Three hundred and twenty feet in length, running round the Concert Hall.
Business communications may be made to
THOMAS HAYES,
Proprietor.
QUANTITY


TAKE THE
Powell or Jackson St. Cable Cars
FOR
SUTRO HEIGHTS
A GALA DAY for the LITTLE ONES
The Pioneer Kinder-Garten
Will Hold a GRAND JUBILEE
Saturday, February 16th
From 10 A. M. to 4 P. M. at Sutro Heights.
Take Your Children for a Day's Enjoyment!
THERE WILL BE
A Grand Open-Air Concert
—BY THE—
SECOND REGIMENT BAND
Take the Powell or Jackson St. Cable Cars which connect with the Trains direct for Sutro Heights

Addendum to:
San Francisco Cable Railway
San Francisco
San Francisco
California

HAER CA-12

HAER
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